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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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See Advertisement page 26, Aug. 3. 3402

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Dated the 13th day of August, 1917. H 500

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SESSION 1917-1918.

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The TECHNICAL LABORATORY COURSES commence 24th September, 1917. H 114

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SESSION 1917-18.

COMMENCING 24th SEPTEMBER, 1917.

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ENGINEERS, with requisite experience, REQUIRED.—Write, BOX N 66, care of DAWSON'S, 121, Cannon Street, E.C. 4. H 499

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ON THE EFFECT OF WAKE-STREAM IN THE CASE OF SINGLE-SCREW STEAMERS.

By C. H. HOLST.

IN previous articles, dealing with the difference in effect of twin screws turning inwards or outwards and with the symptoms of suction,* an attempt was made to explain the influence of the so-called wake-stream and to bring this influence back to a certain factor, to be used in the calculations regarding propeller efficiency. In the present article a further attempt will be made to trace this same influence in the case of single-screw ships, and to indicate a method by which the same may be dealt with in calculation.

Comparison of different examples of single-screw steamers indicates how in some cases the slip of their propellers appears to be exceptionally low, whereas in other cases a similar efficiency of the engine power is obtained with a considerably greater amount of slip; and inasmuch as the object of this study has been to obtain certain figures for values of pressures, from figures furnished by a certain amount of slip, it is necessary to investigate how such low percentages of slip actually can produce pressures which at first sight do not bear to each other the same relation as originally assumed.

It will be observed from the former articles that a greater unit of pressure has been brought into calculation where a greater amount of slip per second has been met with, and it would therefore be in entire contradiction to this assumption if equal or higher pressure values should be connected with smaller values of slip. If, on the contrary, the supposition be strictly adhered to that a greater amount of pressure can only follow from a greater amount of slip, it becomes evident that the object of research must be to find out to what extent the slip of the propeller may be increased by a secondary motion of the water relatively to the screw, not, however, dependent on the propeller itself, but on the form and speed of the ship.

In the same way as the probable direction and velocity of the water closing in about the hull has been obtained in the case of a twin-screw ship, this direction and velocity may be set out on, and obtained from, the drawings of any other vessel, and by doing so the velocity of the water may be accurately determined, as is shown in the accompanying diagrams.

Here, again, the advance of the ship per second is set out on the middle line, and from this point lines are drawn at right angles to the different horizontal sections of the after-body, representing the supposed direction of the flow of water. But as this direction of flow is exactly equal on both sides of the hull, the propeller is supposed to be influenced by a current having a velocity to be measured by the length of the longitudinal component, on each section. These latter lengths are drawn at the back of the stern-post, and they produce a curve which does or does not touch the surface of the propeller.

A closer inspection of these figures will show that in some cases the working surface of the propeller, or part of it, is struck more or less by the motion of the water following the ship, whereas in other cases the total quantity of water following in the wake appears to be moving at such a distance in front of the propeller that no influence of any kind can be exerted on its surface.

Similarly to the cases of twin screws, an unimportant change in the position of the propellers respectively to the hull will cause them to work under quite different conditions; a greater distance from the hull, either transversely or longitudinally, a reduced diameter, a greater depth of the shaft under the water-level, a greater or lesser speed of the ship, and a different fineness of the after-body, will cause those changes of conditions by which it is determined whether the propeller will be, or will not be, affected by the influence of the wake-stream.

In the case of propellers not being affected by it

Fig. 1. U.S.S. BARGE "JUPITER."

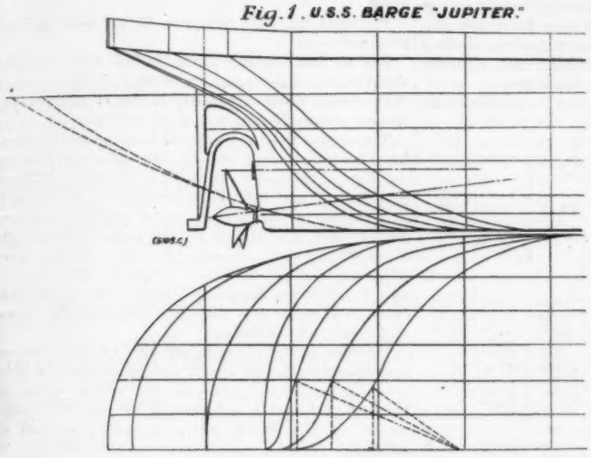


Fig. 3. S.S. "OOSTERDIJK"

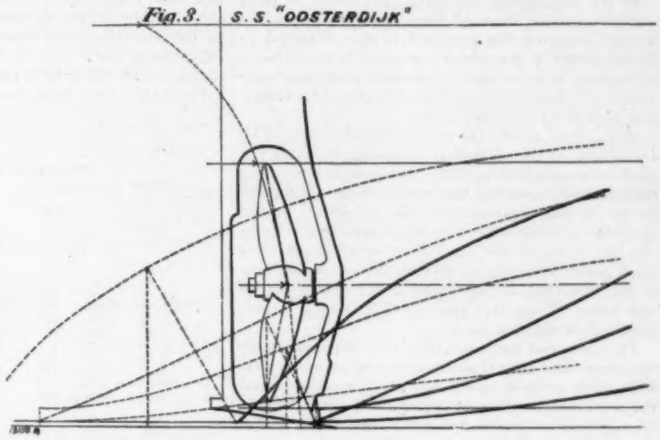
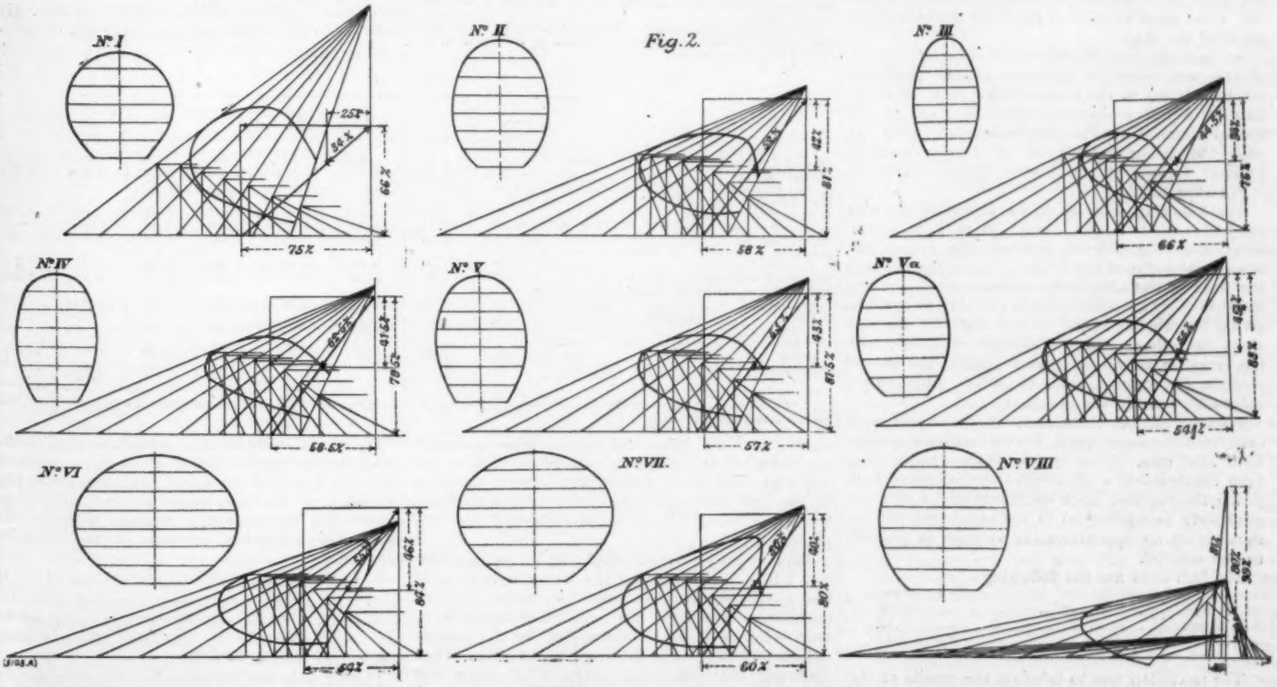


Fig. 2.



* See ENGINEERING, May 4, 1917, page 415, and May 18, 1917, page 468.

the motion of the water depends entirely on the propeller, and its velocity is that which is proportional to the slip; in the case of propellers working under the influence of the wake-stream, on the other hand, the slip is augmented by the velocity of this stream in a certain way, causing an increased velocity of the water relatively to the propeller, and thereby an increased amount of pressure per unit of blade surface acting on the blades, and thus making up for the apparent deficit in pressure which is found when only considering the propeller's slip as producing that pressure.

If the assumption set forth previously be true, "that pressure obtained from the velocity of the water acting on the propeller is only obtained to its full extent if this velocity be given to water being absolutely at rest relatively to that propeller," any velocity of water flowing in the direction of advance will be felt to a double extent.

First, there will be the water thrown backward by the action of the propeller, requiring to be driven against an opposed current, acting on the working surface, and, secondly, the water which is supposed to be at rest relatively to the propeller on the opposite or front side will also have the velocity of the wake-stream, and this velocity must be neutralised and reduced to zero before it can flow in the direction of the water being driven astern and thus fill up the space which would remain empty if it did not do so.

The volume of the water, then, to be driven through the screw disc may thus be increased so much that the engine power is insufficient for this purpose, and the result will be that the water acted upon receives an excessive proportion of rotary movement round the shaft, as in the case of propellers having originally a too great amount of pitch for the obtainable speed of the ship.

An example very suitable to illustrate the value of this assumption is furnished by the published results relating to the United States Navy oil barge Jupiter, a full account of which is given in the special number of *The Shipbuilder* of 1913, on page 156, being an abstract of a paper read by Captain Dyson, of the United States Navy, on "Propeller Efficiency."

The following analysis of the action of the nine propellers tried on this vessel will show the possibility of dealing with this problem. Fig. 1, page 163, is a reproduction of the original engraving, showing the lines of the after-body of this vessel and the location of its propellers, the horizontal broken line giving the original height of the shaft for the first eight propellers, and the inclined shaft-line, with the propeller shown in position, giving the altered position for number nine, by which ultimately a satisfactory result was obtained.

First of all the resistances of the vessel were calculated for each speed, by the author's system, from the data given in the same paper, and from constructing a drawing of the complete hull, giving the required block coefficient of 0.9 with the after-body as reproduced in the article referred to, thus giving an approximation as close as possible to the original.

The hull data are the following:—

	Metres.
Length	36.60
Width	7.32
Draught	2.44
Block coefficient	0.9

The next step was to tabulate the results of this calculation, together with the actual data from the trials, as shown in the annexed Table I.

A comparison of the maximum pressures to be obtained from engines with the resistances at the various speeds indicates that the conditions under which the first propellers were tried must have been quite abnormal, and only very favourable in the last case.

The data given regarding the propellers are stated in the annexed Table II, combined with the results of calculation.

The great variety of propellers tried, all varying in diameter or pitch or surface, or number of revolutions, or number of blades—rendered it desirable to investigate the result of each separately, dealing, however, with every one of them in exactly the same manner.

Though perhaps not absolutely correct, as no drawing of the blade form is given in Captain Dyson's article, a sufficiently close approximation was to be made by knowing their respective areas Thus the form of each blade was drawn to scale, and the same value attributed to their surfaces in any separate case of examination represented by Fig. 2, page 163, which may be described as follows:—

Assuming that the velocity of the water in the fore-and-aft direction is equal to the values given in the table, the velocity relatively to each part of the blade surfaces is to be found by construction. Setting off this supposed velocity as an ordinate, and the respective circumferential velocities as abscissæ, the diagonal lines drawn from the top to the base line will represent the corresponding velocities of each part of the blade, and also the angles under which they meet the water.

From this same figure may then be calculated to

TABLE I.

No. of Propeller.	Speed on Trial. M. per Sec.	Resistances. Form.	Friction in Kg.	Total.	Kg.-M. on Shaft.	Max. pressure obtainable in Kg.	Efficiency in Per Cent.
1	2.28	985	263	1,248	8,400	3,670	34.0
2	2.635	1,520	350	1,870	9,500	3,600	52.0
3	2.42	1,220	295	1,515	8,300	3,420	44.2
4	2.64	1,520	350	1,870	9,250	3,500	53.5
5	2.66	1,560	357	1,917	9,650	3,620	53.0
5a	2.73	1,680	375	2,055	10,200	3,720	55.0
6	2.62	1,490	346	1,836	10,900	4,150	44.5
7	2.72	1,660	372	2,032	11,150	4,100	50.0
8	3.21	2,650	520	3,170	11,300	3,500	90.5

NOTE.—The number of kilogram-metres per second given in this table is equal to 85 per cent. of the indicated horse-power in each case.

The maximum pressure to be obtained is calculated by dividing the number of kilogram-metres per second by the speed of the ship in metres per second.

what extent the water will receive either a certain movement in the direction parallel to that of the ship's advance, or in a direction at right angles to it, the first direction being effective for propulsion, the latter being completely non-effective for this purpose.

Thus by calculation we shall find for the propeller No. I that 75 per cent. of the water motion, or of the power required to cause this motion, will be ineffective, against 63 per cent. which would have been effective if not counteracted by the greater influence of the water now set in rotation. Thus assuming that the total quantity of water will follow the direction of movement of the greater part of 75 per cent. of the total, there will only be available 25 per cent. of the total acting in the useful way. This 25 per cent. set off in the same direction as the 75 per cent. of the majority, and projected on the diagonal representing the 100 per cent. of total available power, cuts off 34 per cent. of this diagonal, indicating an efficiency of equal value as found by comparing the pressure to be expected from engines with the pressure calculated for the ship's resistance at the corresponding speed of 2.28 m. per second.

Propeller No. II sets only 58 per cent. in rotary motion, leaving thus 42 per cent. to go in the direction of advance with the majority of 81 per cent.; 42 per cent. set off in this direction and projected on the 100 per cent. diagonal indicates an efficiency of 52 per cent.

Propeller No. III, setting 66 per cent. in rotary motion against 75 per cent. in the useful direction, indicates an efficiency of 44.5 per cent. against 44.2 per cent.

Propeller No. IV indicates 52.5 per cent. against 53.5 per cent.

Propeller No. V indicates 53 per cent. in both cases.

Propeller No. Va indicates 55 per cent. in both cases.

Propeller No. VI indicates 55 per cent. against 44.5 per cent., and apparently wants a correction.*

Propeller No. VII indicates 50 per cent. in both cases.

Propeller No. VIII indicates 91 per cent. against 90.5 per cent.

Let us first consider propeller No. VIII, as after the position of the propeller shaft had been lowered the propeller itself only partly remained in the wake-stream and partly got out of its influence.

The engine power developed in this case is calculated to be sufficient to drive the water through the full area of the screw disc with a velocity of 3.30 m. per second, and thus is fully sufficient to drive it at a velocity of 4.58 m. per second through the upper 58 per cent., and at 1.38 m. per second through the lower 42 per cent., allowing thus for a certain layer of water having a variable velocity between the upper and lower limits of velocity, the figure indicating somewhat less than half the diameter being under the full influence.

Calculating the pressure per unit of blade surface corresponding to the above velocities, there will be acting a pressure of 4,350 kg. per square metre on the top part and a pressure of 508 kg. per square metre on the lower part, producing a total of 3,220 kg. on 0.74 square metres, and 280 kg. on 0.56 square metres, which, added together, give 3.500 kg. of pressure, against 3.170 kg. of calculated resistance of the vessel.

TABLE II.

No. of Test	1.	2.	3.	4.	5.	5a	6.	7.	8.
Diameter in metres	1.66	1.88	1.75	1.905	1.88	1.88	1.905	1.905	2.06
Pitch in metres	1.30	1.064	1.064	1.115	1.064	1.064	0.915	1.018	1.064
Revolutions per second	3.42	3.54	3.51	3.37	3.34	3.45	3.82	3.44	3.45
No. of blades	4	3	3	3	4	4	3	4	3
Dev. surf. square metre	1.20	0.93	0.61	0.80	1.24	1.24	1.42	1.88	1.30
Pitch per second	4.44	3.76	3.74	3.76	3.56	3.695	3.50	3.50	3.67
Slip per second	2.16	1.125	1.32	1.12	0.90	0.965	0.88	0.78	0.46
Maximum velocity of water through screw disc	3.70	3.40	3.50	3.35	3.42	3.49	3.55	3.27	3.30
Velocity of water due to propeller	8.64	3.375	3.96	3.36	3.60	3.88	2.64	3.12	1.38
Velocity of water by the wake-stream	4.56	5.27	4.84	5.28	5.32	5.46	5.24	5.44	3.20*
Supposed velocity of water in total	13.20	8.645	8.80	8.64	8.92	9.34	7.88	8.56	4.58*
Circumferential velocity of propeller	17.80	21.00	19.30	20.25	19.70	20.40	22.80	20.60	22.30
Efficiency in per cent.	34.00	52.00	44.5	52.5	53.00	55.00	55.00	50.00	91.00

* The influence of the wake-stream is apparently only felt as working on the top half of the propeller (see figure). In all other cases it acts on the full area.

The exceptionally favourable position of the blades, owing to the small amount of pitch, as compared with the speed of the barge produced a very high efficiency in this case, being as much as 90.5 per cent. The corresponding diagram indicates this favourable condition as well as the foregoing calculation.

Firstly.—As the circumferential velocity of No. VI is by 3.20 m. per second greater than that of No. III.

Secondly.—As the velocity of the water is smaller for No. VI than for No. III, the difference being 0.62 m. per second.

Thirdly.—As the Propeller No. VI, when working free from the influence of the wake-stream, would have been capable of producing a total pressure of 3,650 kg., against only 1,520 kg. for No. III.

Fourthly.—As from comparison of the obtained results it appears that even under the abnormal conditions of the eight propellers tested the greater engine power is accompanied with a better speed, and that only No. VI would show less speed at the corresponding power.

Taking all these reasons into consideration, it appears probable that a printing error in the original table gave the speed as 5.045 knots, which corresponds

* It appears reasonable to apply a correction to the figures given in the tables as relating to No. VI propeller, as it is not likely that propellers Nos. III and VI should produce a nearly similar effect, viz., 44.2 per cent. and 44.5 per cent.

to 2.62 m. per second, whereas it should have been 2.78 m. per second.

Substituting this latter value for speed in the tables given, we will then find for Table No. I—

	Kg.
Resistance due to form	1,820
Resistance due to friction	390
Total resistance	2,210
Maximum pressure to be obtained at a speed of 2.78 m. per second	3,900
	Per cent.
Efficiency of propeller	56.5

and for Table No. II—

	M.
Slip per second	0.72
	M. per Sec.
Velocity of water due to action of propeller	2.16
Velocity of water due to wake-stream...	5.56
Total velocity of water	7.72

all other figures remaining unchanged.

The diagram No. VI, page 163, has been constructed on these corrected figures. The very slight differences in results are easily explained when, considering that the forms of the different blades are only estimated, a somewhat wider form on the top of the blades will result in a lower percentage of effect.

An example of quite different nature is to be found in the results of the steamers Oosterdijk and Westerdijk, of the Holland-Amerika Line, a diagram of which is given in Fig. 3, page 163.

As will be seen, the influence of the wake-stream is here supposed to make itself felt over the full surface of the propeller, the top half being struck on the working surface, whereas the lower half is only influenced on the back of the blade.

The vessel's calculated resistance, at a speed of 6.28 m. per second, is equal to about 37 to 38 tons. No correct drawing of the complete hull having been at the author's disposition, this value is only to be considered as a close approximation. The speed was taken as a mean over 24 hours from the ship's log-book. The propeller is driven by a reciprocating engine of 4,881 i.h.p., equal to 330 metre-tons per second transmitted to the shaft, and thus a maximum pressure of 52.5 tons may be expected.

When working under the conditions of not being influenced by the wake-stream, there would be found a pressure of 1,940 kg. per square metre only, owing to the slip of 0.77 m. per second, the propeller having a pitch of 20 ft., or 6.096 m., and a pitch per second equal to 7.05 m. per second when turning at 69.4 revolutions per minute.

The pressure of 1,940 kg. per square metre, acting on a surface of 10.8 square metres, would produce a total pressure of only 21 tons, a value which would neither correspond with the pressure to be expected from the engines nor with the resistance of the ship.

Now taking into account the extra velocity of the water caused by the wake-stream, we shall find, however, that the top part of the propeller works in water having a mean velocity of 2.50 m. per second in excess of that which is given by the action of the propeller, viz., a total of 5.58 m. per second, producing a pressure of 34 tons on the top half, while the lower half, working in water having an extra velocity of 0.63 m. per second, or a total velocity of 3.71 m. per second, produces a pressure of 15.2 tons, thus amounting to a total pressure of 49.2 tons, pointing to an efficiency of the propeller of 76.5 per cent. when comparing the pressure acting on the propeller with the resistance of the ship.

The total amount of the engine power is absorbed at the given speed when driving the water through the full area of the screw disc at a velocity of 4.68 m. per second, and the mean velocity as found by the method here described is equal to 4.64 m. per second. By construction it is further found that the efficiency of the propeller must be very nearly equal to 81 per cent. Thus considering that at the speed as taken from the ship's log book the resistance may have been slightly increased by the influence of wind or sea, the results of practice and calculation will then correspond at 81 per cent. of 49.2 tons, being 39.5 tons, which is only 1.5 ton in excess of the calculated resistance, at the given speed, when obtained in smooth water and without wind.

From the data obtained from the measured mile trials of the steamship Koningin Wilhelmina* the same calculation was made, with the following results :—

—	Maximum from Engines.	Speed in Metres per Second.	Calculated Resistance, Kilograms.	Pressure without Wake-stream.	Pressure including Wake-stream.	Efficiency in Per Cent.
	tons					
At full power	31.8	7.1	29.000	12.500	31.900	91
At half-power	16.6	5.46	14.600	6.000	16.500	88

At the higher speed the influence of the wake-stream causes a somewhat higher percentage of efficiency, by bearing a somewhat larger proportion to the total velocity of the water, as compared with that simply obtained from the propeller's pitch per second.

At the slower speed this proportion is as 1.80 m. per second by the propeller, against 1.56 m. per second by wake-stream. At the maximum speed the propeller gives 2.48 m. per second, to which is to be added 2.20 m. per second for wake influence, the corresponding "proportionate" velocity being only 2.15 m. per second.

Other ships, when their results were studied in the same way, gave exactly similar results; whenever the propeller is touched by the influence of the wake an apparently small amount of slip is met with. This indicates an extra movement of the water set up by the ship, which may be taken into account in the manner above indicated.

On the contrary, whenever the propeller stands free from this influence the quantity of water set in motion by the propeller appears to correspond with the pressure which is to be looked for, thus proving that the velocity of the water with respect to the propeller is the true factor for determining the pressure which is acting on the surface of its blades.

* Of the Steamship Company Nederland.

COAL-HANDLING PLANT AT DURBAN.

By GEORGE FREDERICK ZIMMER, M. Inst. C.E.

WE illustrate this week, on Plate XVI and on pages 166, 167 and 174, a very important installation of coal-handling plant which has been erected at Durban by Messrs. Fraser and Chalmers, Limited, of Erith, Kent. The plant was officially inaugurated on February 9 last, when its working was demonstrated by the loading of about 500 tons of coal into a vessel alongside the quay. The occasion was made a public function, and in the course of some speeches delivered at a luncheon which formed part of the proceedings some interesting facts were stated relating to the part taken by Natal in the development of the coal industry in South Africa. The Mayor of Durban, Mr. J. H. Nicholson, presided, and the principal speakers were Sir Thomas Hyslop, the Mayor, Sir William Hoy (general manager of the South African Railways), and Captain Carneireo (director of the Portuguese Railways).

Natal, which has the premier port of the Union, was the first to discover coal, in 1838, and to start mining, in 1888. Cape Town commenced mining in 1865, the output then being 16,500 tons, which amount had increased in 1899 to 208,655 tons, its output after that date being comparatively insignificant as compared with that of Natal and the Transvaal, which latter commenced mining in 1893.

In 1899 Natal's output was 28,700 tons, whilst in 1916 it was 3,366,202 tons, an increase of 33 per cent. over the previous year, and of 80 per cent. over 1907. In 1916 the annual output of the whole country rose to over 10,000,000 tons. In 1906 the coal bunkered in Natal amounted to 846,000 tons, and in 1916 to 1,000,000 tons. In 1916 the whole South African output was 14 per cent. better than that of 1913, which was the next best year. In 1916 the tonnage of bunkering and cargo amounted to over 3,000,000 tons, or 500,000 tons more than in 1913.

The development of the coal industry will be most beneficial to Natal, as it will result in largely increasing traffic to the coast. Railway facilities to-day are much improved since the early days of the coal traffic. In 1907 it took 90 hours for the coal to travel from the mines to the harbour, and to-day—with a greatly increased load—it can be conveyed in 70 hours, and 6,000 tons to 7,000 tons arrive daily at the port.

The importance of the coaling industry has always been realised in South Africa, and not only from the commercial point of view; the advantage of having large supplies of coal available has been especially brought home during this war, and the installation of such an important coaling plant as that now under notice is particularly welcome at the present time. It may be interesting to know that the coal produced since 1888 to date, in South Africa, amounts to the value of 37,000,000*l.*

The progress of the port of Durban since the days of the Boer War is most gratifying. In those days mail steamers and smaller craft lay outside the harbour, and cargo and passengers were unloaded thence into tugs and lighters. Now the mail steamers and larger vessels come inside and are unloaded alongside the wharf. This enormous advance may be attributed partly to the great increase in the coal industry at the port.

About the year 1905 it was found that the old methods of coaling, by means of baskets, were altogether inadequate; designs were therefore got out for a coaling plant, which was erected in 1907, and has done excellent service during the last 10 years. Before the erection of this first coal-loading plant the coal loaded annually at Durban amounted to 847,000 tons, but in 10 years it has risen to more than double that amount, viz., 1,750,000 tons. In 1913 it was decided that a new coaling plant was necessary, partly as an extension, and partly to take the place of the old one, should anything go wrong with it. Messrs. Fraser and Chalmers secured the contract for this new plant, and it was to have been erected in 1915, but owing to the outbreak of war, and to Messrs. Fraser and Chalmers' premises being requisitioned by the Government, that was rendered impossible. Now, however, the plant is almost entirely completed, and Messrs. Fraser and Chalmers are to be congratulated upon the excellent work they have done, as is also Mr. Thompson, the representative of the Administration, who came to England, to here supervise the construction of the plant.

The illustrations on Plate XVI. show the general arrangement of the new coaling plant at "The Bluff," with a sufficient amount of detail to explain the working of the scheme, and although the plant does not embody any new principles it is imposing on account of its magnitude and the careful attention paid to the most minute features.

Generally speaking, the installations consist of four essential units: I—The dumper, with which the coal trucks are discharged into a large concentrating pan. II—An inclined belt conveyor, which receives the coal from this pan and elevates it up an incline to III, a second band conveyor, which runs in an elevated gantry parallel to the quay-wall and which feeds, by means of a tripper, on to IV, a hinged telescopic band conveyor, which is mounted on a travelling tower and can be fed with coal in whatever position it may be, and discharge into the vessel.

I. *The Dumper* is one of McMyler's well-known machines designed to handle 75-ton trucks (short tons), and to discharge them by tipping them over sideways into the large concentrating pan, which is shown on Figs. 1 and 2. The dumper is controlled by three 150-h.p. Westinghouse motors with the latest pattern contact or control gear.

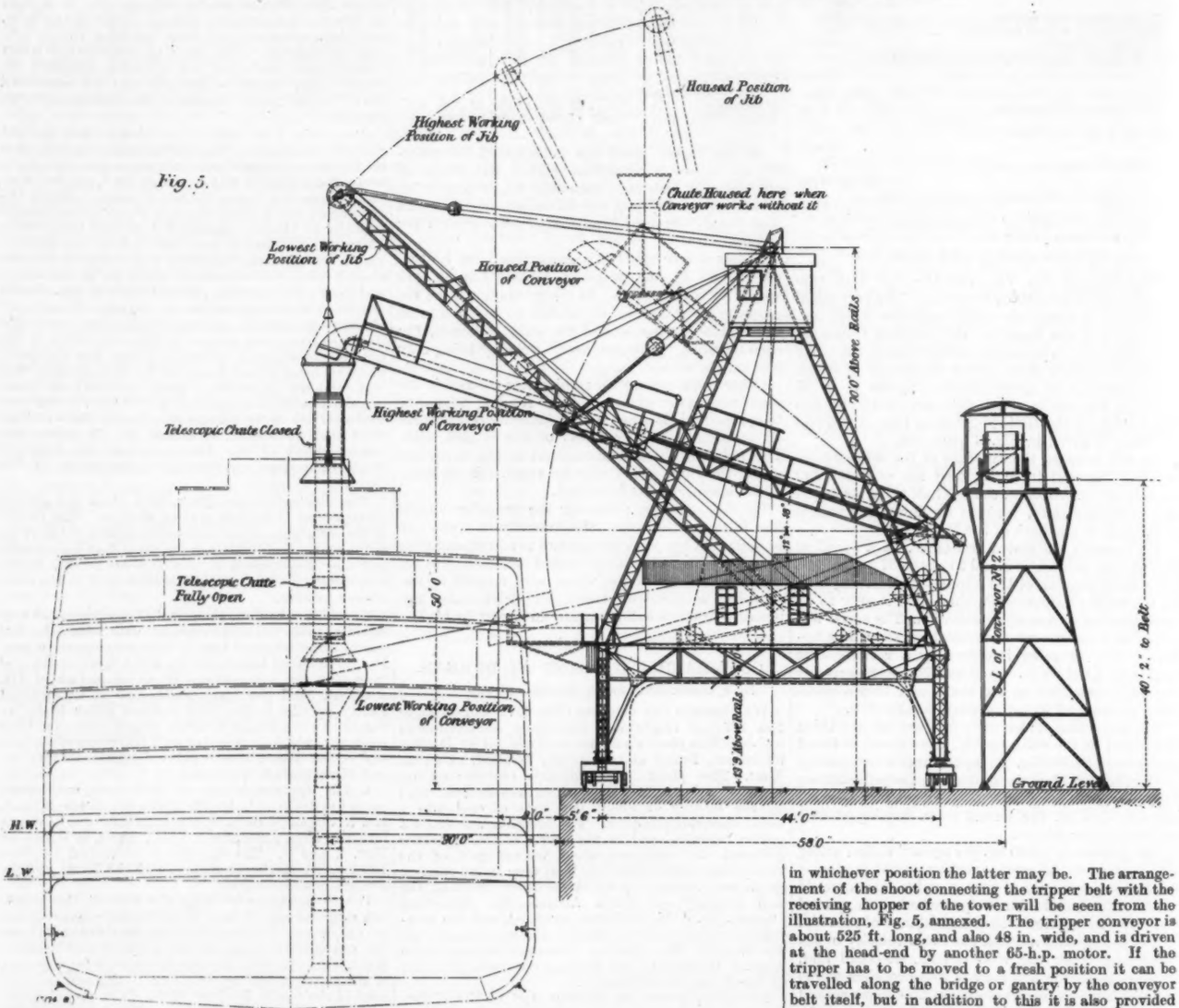
It was necessary to raise the coal at this point, not only because it was undesirable to excavate so near the water, but also in order to be able to feed from the concentrating pan to the existing coal-handling plant, and to provide the necessary energy for disposing of the empty trucks by gravity; to this end the rail-level of the tippler is about 12 ft. above ground-level, and the inclined dotted line on Fig. 1 indicates the ramp up which the coal trucks are pushed by means of a "pig." The normal position of this "pig" when not in use is in the pit A—B—between the rails of the track on which the coal arrives—so that the trucks can pass over it (see plan, Fig. 2). The full trucks gravitate to a point just beyond A—B and there come to a standstill, at the foot of the ramp, from which point they are handled by the "pig," which emerges from the pit and engages with the central buffer at the rear of the truck and pushes the latter up to the dumper. Immediately the truck arrives at the dumping platform the "pig" returns by gravity into its original position in the pit ready for the next truck. After the coal has been tipped the now empty trucks run by gravity down the incline on the other side, to the sorting sidings. The dumper is capable of dealing with any size wagon up to 75 tons capacity, or it will accommodate two smaller ones at the same time equally well. The capacity has been kept on the high side in order to allow for delays which occasionally occur in the handling and marshalling of the trucks, and to bridge over such gaps in the continuity of the proceedings sufficient storage-room is allowed in the concentrating pan for about 150 tons of coal. The handling of the trucks does not therefore have to stop when the conveyor is held up for a few minutes when changing holds, or for other causes.

In a lay-out of this kind it has been necessary to very carefully consider the sidings, so that the full trucks can be easily fed down to the tippler or dumper, and then led away to the empty sidings. The

COAL-HANDLING PLANT AT DURBAN.

CONSTRUCTED BY MESSRS. FRASER AND CHALMERS, LIMITED, ENGINEERS, ERITH.

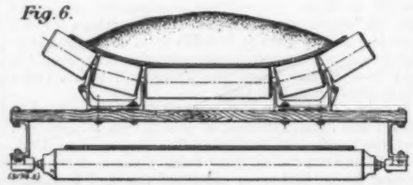
Fig. 5.



concentrating pan into which the coal is tipped is so arranged that it may either feed on to the inclined belt or into tubs standing on trucks which are running on the bucket car line C—D underneath the concentrating pan. These tubs are of special construction to be handled by an existing coaling plant, and consist of skips holding about 7 tons to 8 tons of coal. Six of these can be automatically and simultaneously filled between points C and D on the line, by means of valves which have been arranged at the six corresponding outlets from the concentrating pan. These valves are all opened simultaneously by a motor, and the coal is allowed to flow until the trucks are full, when all valves are again closed by the motor, being so arranged that they cannot overfill the skips. When the coal is fed on to the conveyor this is done without the employment of any of the usual feeding devices, as Messrs. Fraser and Chalmers have found, from experience gained with other plants, that a properly-designed feeding shoot will feed the coal sweetly down to the belt without overloading it, and without any necessity for an automatic feeder of any kind.

II. *The Inclined Belt, known as Conveyor No.* 1, which is about 230 ft. long, from centre to centre of terminals, and 48 in. wide, takes the coal from the concentrating pan to an intermediate tower, up an incline of 20 deg. It is carried on a bridge entirely enclosed and provided with a foot-walk on each side of the belt, the driving gear being at the head end, and a 65-h.p. motor is provided for this. A set of troughing and return idlers, as used for these band

Fig. 6.



conveyors, is shown in Fig. 6, annexed; they are fitted with ball bearings throughout. The belt itself is a 10-ply composite rubber-canvas one with $\frac{3}{8}$ in. thickness of pure rubber on the working side. The bridge will be seen in the views, Figs. 8 and 9, page 174. At the intermediate tower the coal is discharged into a three-way shoot, from which it can—by manipulation of the valves—be fed either direct to the travelling tower, if it should happen to stand in this position, or to conveyor No. 2, which runs parallel to the quay-front, while a third outlet is provided in order that the coal may be fed to a similar conveyor, the erection of which is contemplated as a future extension, and which is to run to the opposite side to the one already in use; a portion of this additional conveyor is shown in dotted lines in Fig. 1.

III. *The Tripper Conveyor*, running along parallel to the quay-wall, is known as conveyor No. 2, and is provided with a tripper, through which it discharges the coal to the receiving hopper of the travelling tower in whichever position the latter may be. The arrangement of the shoot connecting the tripper belt with the receiving hopper of the tower will be seen from the illustration, Fig. 5, annexed. The tripper conveyor is about 525 ft. long, and also 48 in. wide, and is driven at the head-end by another 65-h.p. motor. If the tripper has to be moved to a fresh position it can be travelled along the bridge or gantry by the conveyor belt itself, but in addition to this it is also provided with an auxiliary hand-travelling gear, so that it can be moved if the belt is not running.

One feature of the tripper is that it is automatically locked during the time it is discharging coal. The upper part of the gantry forming the protection for the tripper belt is, on the side next the tower, only closed in for a portion of its depth below the roof, the lower part forming a slot-like opening interrupted only by the stanchions by which the roof is supported. A good idea of this construction will be obtained from the view, Fig. 7, on the opposite page. In Fig. 2, where the gantries of both conveyors are shown in plan, the peculiar wind bracings are also indicated in arch-like curves, which are also a distinctly novel feature in a plant of this kind.

IV. *The Travelling Tower* is shown in Figs. 3 and 4, and its principal object is to support a telescopic-hinged belt conveyor which has a wide range of movement, as indicated on the view, Fig. 5, which shows in dotted lines the extreme positions of the delivery end. This conveyor can best be seen from the side elevation, Fig. 4, where the conveyor is shown at its minimum length. The head terminal pulley is marked A; from this the band returns empty over a number of idlers to the drum B, thence over drums C, D, E and F, from which latter point the loaded band starts to the head terminal A. D^1 shows the position of drum D when the telescopic conveyor is racked out to its uttermost length. This drum D travels on a prescribed path parallel to the girder G—H, forming a bight which pays out the band and takes up the slack as required for the different lengths. The shortest length

COAL-HANDLING PLANT AT DURBAN.

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Fig. 7. Travelling Tower with Telescopic Hinged Belt Conveyor.

of the band from the supporting trunnion to the centre of the head pulley is 55 ft., and when racked out to the uttermost it is 77 ft. The extreme positions are shown in dotted lines in Fig. 5. We thus see that the conveyor is capable of discharging coal at a maximum height of 50 ft. above the quay level, or a total height of 60 ft. above the water-line. It can also be adapted, by its telescopic movement, to deliver at a distance varying from 8 ft. to 30 ft. from the edge of the quay-wall, so that it is capable of coaling any size of vessel calling at the port.

This great flexibility, which is a special feature, is obtained by making the conveyor both luffing and telescopic, so that by a combination of these two facilities the discharging terminal can be placed in any position required within the limits mentioned. The conveyor can either feed direct into the ship or can discharge by way of the telescopic anti-breakage shoot which is provided, and which is supported by the large box-lattice shear-legs which form a part of the tower. The shoot is lowered into the hold of the vessel until the lower end reaches to the bottom, the coal is then fed in at the top until the shoot is full, when the shoot is gradually raised to allow the coal in it to pass out at the same rate at which it is fed in at the top of the conveyor; in this way the coal can be lowered without a drop, whereby breakage is avoided. It may here be mentioned that as the South African coal is particularly friable, special care was taken in the construction of this plant to eliminate any undue breakage of the coal by avoiding as much as possible any direct fall at the points of transference.

The whole tower, which weighs approximately

150 tons, is arranged to travel along the quay front on two double rail tracks, 43 ft. 6 in. apart, at the rate of 80 ft. per minute, and the telescopic and luffing motion of the conveyor and the telescopic and luffing motion of the anti-breakage shoot are so arranged that they can be operated in a minimum of time, so that it is possible, for instance, for the man in charge, after completing coaling at one hold, to withdraw the shoot and conveyor and move the whole apparatus along to the new position, and start coaling again at the next hold with a waste of time of only about 2½ minutes to 3 minutes.

These quick movements are only possible because the whole plant is controlled by one man, who has his stand in the cabin shown in Figs. 3, 4 and 5, at the top of the travelling tower, from which point of vantage he can closely watch and adjust all operations. All the master controllers which operate the two main belts, Nos. 1 and 2, and the telescopic belt, are placed in this cabin, as well as those of the luffing and telescopic motions of the belt conveyor, and the anti-breakage shoot in the tower, and all movements of the tower itself. As this one man has all these motions under his control, he is able to combine them in such a way that no time is lost and that accidents are extremely unlikely. All motions on the tower are controlled by seven electric motors. These include: traversing motor, 30 h.p.; conveyor drive motor, 30 h.p.; conveyor telescoping motor, 10 h.p.; conveyor luffing motor, 40 h.p.; shoot telescoping motor, 6 h.p.; shoot hoisting motor, 25 h.p.; jib luffing motor, 40 h.p. With this method of driving all telephones and signal-bells, &c., which play an important part in some older installations, can be entirely dispensed with.

The coal-dumping plant is also under the control of one man, so that these two drivers are the only two skilled men that it is necessary to have about the place. As far as the dumper is concerned, all that the driver has to do is to keep a constant supply of coal in the pan, and there is thus no need for any form of signalling with its inherent dangers, throughout the plant.

All movements are provided with automatic cut-outs, so that the whole plant stops the moment anything goes wrong. In addition to this provision there are emergency push-button cut-outs arranged at intervals along all gantries or bridges, and at different points on the tower, so that if an accident should occur through any cause the whole plant can be immediately stopped by the use of any one of these push-buttons. This special feature in the complete electrical control of the plant is one of the chief developments in this latest coaling installation, as it not only reduces the running of an otherwise complicated plant to a very simple business, but it also saves labour expenses, which matter is equally essential to the commercial success of the plant.

The requirements laid down by the South African Government were that the plant should be capable of loading coal on board at any rate of speed between 200 tons and 600 tons per hour, but it is actually capable of dealing with 200 tons to 1,000 tons per hour as a normal load, and if at all pushed, can easily carry more than the 1,000 tons, provided external conditions are favourable, such, for instance, as the supply of trucks in quick succession and the necessary trimming in the vessel. The rate of travel of the belt when dealing with 200 tons per hour is 120 ft. per minute, and when dealing with 1,000 tons it is 600 ft. per minute. The requirement that the tonnage carried over the belt should be varied was specified so that the coal should be fed at a low speed when discharging to side or head ports, and at the maximum speed, if desirable, when loading into open hatches, or at any speed between the minimum and maximum limit at the discretion of the driver on the tower, who can see exactly how much coal can be taken, and increase or decrease the speed at which it is fed to the boat according to circumstances. These requirements were happily met by varying the speed of the conveyor belts, instead of depending on the opening or shutting of regulating valves, which could not well be controlled from a central point, and would therefore necessitate the employment of additional labour, signalling, and other complications. The plan adopted also allows the belt to run at its full load all the while, whatever the capacity of the plant at that particular time, which, of course, is the most economical arrangement for the life of the belt.

The 500-volt direct-current electrical current is conveyed to the various motors by means of a series of trolley wires, which are attached to the structures supporting the conveyor belts, and which feed to and from the tower by trolley collectors. The whole plant can be lit up, and is therefore capable of working at night, the current for the lighting being 200 volts alternating current. The total horse-power on this plant is about 781.

Great care has been taken in the design of the plant, so that any part of the machinery on the tower or elsewhere can be taken out and lowered to the ground for repairs in the shortest possible time. All winches, both for the dumper and other machinery houses, are provided with runways over them for the accommodation of blocks and tackle, which will always be available for hoisting any part of the plant from its position and lowering it on to railway trucks in case of any repairs being necessary. The telescopic shoot of the tower is also so designed that it can be placed on a railway truck running on the rails under the tower.

Both the main belts are driven by single terminal driving drums, in preference to the tandem driving pulleys favoured by some engineers, and the peculiar arrangement of the idlers of the return band close to the driving terminal will give the drum the necessary grip on the band without its being necessary to employ these so-called tandem driving pulleys. The coal, as it passes over the main tripper belt, No. 2, is automatically weighed by a Merrick weighing machine, so that an accurate account can be kept of the amount of coal loaded.

The plant, photographs of which are reproduced in Figs. 7, 8 and 9, on pages 167 and 174, was designed and manufactured at the Erith Works of Messrs. Fraser and Chalmers, Limited, and erected at Durban by one of their engineers, who went specially for the purpose to South Africa.

INDUSTRIAL NOTES.

The Cotton Control Board issued last Friday, the 10th inst., their recommendations for the control of the cotton industry. The scheme will be tested for a period of three months. It includes a week's notice to all cotton-spinning firms, including spinners of waste, ordering a stoppage of all but 60 per cent. of their total spindleage and the equivalent preparatory machinery, on and after September 3. Firms who work more than this percentage will be mulct in levies per spindle, and the money which accrues from the payment of such levies by spinners of both Egyptian and American cotton will be used by the Board of Control to prevent the depletion of the trade-union funds, to conciliate the want arising from the temporary unemployment of the operatives, and for any other purposes brought on by the crisis which the Board may think proper. The scheme has received the approbation of the Board of Trade.

Mr. A. Herbert Dixon, chairman of the Cotton Control Board, has made the following statement with reference to the scheme in question:—

"The scheme has been adopted after the most careful and searching inquiry into all the facts of the present situation and the anticipated future necessities of the industry. It has been drawn up with the sincere desire and intention of distributing as equally and fairly as possible the inevitable burdens upon all sections of the industry, and I have been greatly assisted and encouraged, not only by the co-operation of every member of the Control Board, but by various sections of the trade, both employers and operatives, with whom the Board have been in constant touch.

"In view of the difficulties of the situation and the necessity for subordinating individual views and interests to the general welfare of the industry I feel confident that I can rely on the loyal co-operation of all concerned. The scheme is only being put into operation for a period of three months, in consequence of the very strong effort being made by the Shipping Controller to increase the tonnage available for cotton."

A matter of considerable interest and importance to the progress of Liverpool as a port, says *The Liverpool Courier*, was mentioned at a meeting of the Mersey Dock Board held on the 9th inst.

A minute of the Works Committee stated that permission had been given to Mr. J. J. O'Neill, on behalf of a company named the Mersey Shipbuilding Company, to rent a portion of what was formerly the old shipbuilding yard at Seacombe.

Mr. J. W. Hughes, in moving the adoption of the minutes, said he was sure the members of the Board would feel considerable satisfaction that there was a prospect of the Board getting some revenue from the land, which had been lying vacant at Seacombe for so long, and which was to be used for building ships which were so much wanted.

This announcement will be received with much satisfaction on Merseyside, indicating as it does that great as is the part which this port has played in shipbuilding, it is destined to play even a greater part in that urgent and essential national work of re-establishing Britain's supply of merchant ships, a supply which the acts of the German pirates have diminished. The output at the new shipping yard at Seacombe, which, it is understood, will be made ready and fitted with the necessary plant without delay, will be a valuable aid to that end.

The Mersey Shipbuilding Company is a newly-formed company, and whilst for the present it is not desirable that its identity should be made known, it may be stated that those who have brought it into being are influentially connected with shipping, both in and outside Liverpool, and financially powerful, and they may be relied upon for carrying through the undertaking with complete success.

The site chosen at Seacombe is regarded as a most suitable one for the purpose of a modern shipyard.

Following our announcement on page 144 *ante*, to the effect that the Minister of Munitions (Mr. Churchill) on the 1st inst. met representatives of the shipbuilding and engineering trades in London, we are now able to announce that he received on the 8th inst., at the Ministry of Munitions, a deputation of employers' organisations, who discussed with him a variety of questions relating to labour and manufacture. Mr. G. Terrell, M.P., introduced the deputation, which included representatives of the Federation of British Industries, the Association of Controlled Establishments, and the National Union of Manufacturers. Among the speakers were Alderman Hobson, of Sheffield, Mr. Gilbertson, of South Wales, and Mr. Spencer, of Hull. Mr. Churchill promised to consider all the points raised, and invited the deputation to meet him again upon any points which they desired to discuss with the Ministry.

We read in *The Iron Trade Review*, Cleveland, Ohio, that one of the largest Government arsenals recently asked for bids on a lot of steel castings. The specifications and blue prints were sent to a number of prominent steel foundrymen throughout the country, but when the day for opening the bids arrived it was found that only one proposal had been submitted. Does this indicate lack of patriotism on the part of steel foundrymen in a time of great national stress? On the surface, such might appear to be the case, but, as frequently occurs, a little investigation into underlying causes shows that the trouble is due entirely to commercially impossible conditions which the Government insists upon.

In the case under consideration, adds our American contemporary, the specifications for converter steel castings contained sulphur requirements which are impossible of attainment at present, due to irregularities in the coke supply. Commercial buyers, realising that foundrymen recently have had to use coke containing as much as 23 per cent. of ash and 2.25 per cent. of sulphur, have waived the extremely low limits demanded by some of their specifications. In the army organisations in charge of the arsenals, however, no one could be found who would assume the responsibility for any rearrangement to meet existing conditions, even though one foundryman interested in the matter took the question up with the highest authorities in Washington.

In brief, concludes the journal from which we quote, at a time when the Government needs castings as it never needed them before, nothing is being accomplished, and no one can be found who has the nerve to cut the maze of red tape surrounding every order. This problem never will be solved satisfactorily until the business of supplying the army is placed in the hands of business men with technical and commercial training. In the very nature of things the training of a regular army officer does not fit him to deal with commercial problems in an ordinary businesslike manner. At a time like the present would it not be more sensible to release the energies of army officers for service in the fighting contingents, leaving the task of supplying the army in the hands of men with business experience?

We arrived at practically the same conclusions as *The Iron Trade Review* when dealing in a former note (see page 117 *ante*) with the question of inspection by army officers. Our readers will find on page 148 of our last issue information on the new specifications for steel castings for use in the United States Navy.

The Railway Review, Chicago, deprecates the employment of women for doing heavy labour. The placing of women for carrying out heavy work, for which the sex is by nature and by habit unfitted, is altogether regrettable. It will be much more creditable, says the American journal, if under existing conditions of labour shortage we find out ways of cutting out unnecessary labour and devise mechanical means for reducing all hand work to a minimum. There are many labour-saving machines and appliances, and there is still a large amount of lost motion everywhere. Let the brains help out the hands and the backs.

Our contemporary is quite right, but in the present emergency there is a vast amount of work which women can do, and which they have asked to be allowed to do, in order to release men for service in the fighting line. Throughout the whole of Great Britain women have freely offered their services. They have not been content to continue in their pre-war avocations; there are many employments in connection with the army itself which they felt capable of performing as well as men, and they have entered these employments, as drivers in the motor transport section among other

occupations, in which they work bravely and cheerfully, to the satisfaction of all concerned.

In this connection we may add that in the course of a conference held last Tuesday at the Institute, Golders Green, Mrs. W. C. Anderson (Miss Mary Macarthur) said that the ranks of women engaged in industrial occupations had increased by 30 per cent. since the war; there was now at least 1,000,000 women doing work which had been formerly done by men. Much of the work was unsuitable for women and was performed under unsuitable conditions. It was not yet possible to gauge the price that might have to be paid from the point of view of the welfare of the race. In reconstructing industry the aim should be to secure as wide a field as possible for female labour, consistent with the maintenance of health and the welfare of the race, and this aim could be reached either by trade union organisation or by State action, but it could be done best by State action. Trade unionism for women had made great progress during the war; it was well for the women to belong to the same union as the men, if possible, but their membership should not be a paper membership only.

We read in *The Glasgow Herald* that in a letter which they have sent to the Committee on Production, the Executive Council of the Amalgamated Society of Engineers state that they have received "numerous resolutions from branches and district committees expressing great dissatisfaction" with the recent wages award. They regard it as essential, they add, that the Committee should be made acquainted with the feeling throughout the country that 3*s.* a week is "totally inadequate to meet the requirements of the case due to the increased cost of living." Writing on the same subject, Mr. Brodie says that the award "has not been very favourably received" by members, who consider that "owing to the great increase in the cost of living on which their demand was based, and the fact that most of our best men are making little over the minimum rate unless by working overtime, they were entitled to more generous treatment." Of the award to engineers employed in steel works, Mr. Brodie says that it "has not had a very stimulating effect as far as increasing output is concerned." The earnings of engineers in this branch of industry do not compare, he adds, with the earnings of many of the other workers. Most of the remaining organising delegates report in similar strain, the Irish representative declaring that "the whole proceeding lends itself to rebellion amongst the rank and file."

The Engineering and Shipbuilding Trades Central Advisory Committee (Operatives), which has recently been appointed by the Minister of Labour to advise and assist the Employment Department on questions affecting workpeople in those industries, held its second meeting on Thursday, the 9th inst.

The arrangements for the issue of railway warrants at reduced rates to workmen placed in work of national importance through the Employment Exchanges were reported to the committee, who expressed their satisfaction. The committee recommended that the limit of distance from an office of the employment fund within which workmen must sign the vacant book daily should be reduced from 3 miles to 2 miles. They also discussed, among other matters, the question of co-operation with the Employment Exchanges with regard to the transfer of shipyard labour.

The following are the conditions which govern the conversion of the 15*s.* war bonus into war wages, contained in the agreement recently arrived at between the Railway Executive Committee, on behalf of the Government, and the National Union of Railwaymen:—

"Such additional wages are to be regarded as a war advance intended to assist in meeting the increased cost of living, and are to be recognised as due to and dependent on the existence of the abnormal conditions now prevailing in consequence of the war.

"The truce entered into at the meeting between a committee of general managers and representatives of the two trade unions on October 1, 1914, shall continue in force during the operation of this agreement or any modification thereof.

"This agreement shall remain in operation during the war, and thereafter shall be subject to three months' notice in writing by either side. Provided that if at any time after the expiration of three months from the date hereof there shall be a substantial change in the abnormal conditions now prevailing it shall be open to either side to demand a revision of the additional wages set out above, and the said wages shall be revised according to any agreement come to."

The Workmen's Compensation (War Addition) Bill was read a second time last Monday, the 13th inst., in the House of Commons. It provides that on and after September 1 all weekly payments under the Workmen's Compensation Act, 1906, are to be increased by 25 per cent., the increase being due to the rise in the cost of living.

In the report from the Committee of Public Accounts (House of Commons, July 31, 1917) it is stated that the expenditure incurred by the Ministry of Munitions in housing schemes took the form of (*a*) direct grants to local authorities in aid of permanent building schemes; (*b*) loans to contractors; (*c*) cost of housing accommodation, permanent or temporary, in the neighbourhood of national factories.

Provision of temporary housing had been made for a maximum of 19,565 workers, at an estimated cost of 1,088,167*l.*, but the numbers in occupation at April, 1917, were 11,005 only. Contributions to permanent housing schemes of corporations, &c., had been made to a value of 24,040*l.* on a total estimated cost of 90,359*l.*, representing a percentage of 26½. Contributions of 73,500*l.* to permanent housing schemes of contractors had been made by allowance from excess profits, the cost of the cottages and tenements being 289,372*l.* Loans for permanent housing schemes of contractors had been made to the value of 380,500*l.*, at rates of interest varying from 4 per cent. to 5 per cent., the period of repayment being 40 years, except in one case, where it is 30 years. In addition to the housing scheme at Woolwich carried out by the Office of Works (the total net cost of which is estimated at about 808,000*l.*), the Ministry has made provision for accommodation for 8,326 workers in the Woolwich district at an estimated cost of 980,803*l.*, the numbers in occupation at April, 1917, being 3,730 only.

Mr. Churchill, the Minister for Munitions, dealing in Parliament last Wednesday with the Munitions of War Bill, said he had hoped to postpone the Bill till the autumn, when it could have been brought forward as a part of a larger and deliberately negotiated settlement of labour questions affecting the Ministry of Munitions. But the attitude of the trade unions and of the committee of the Employers' Association convinced him that it would not be right to let Parliament disperse without having settled the urgent point of the leaving certificate. He was confident the House, knowing the situation, would give the Minister affected all the assistance he required, and therefore he decided to lighten the Bill as much as possible and concentrate on the points which required immediate settlement. That did not prejudice the resumption of the discussion in the autumn. He hoped that they would be able then to bring forward measures which would deal with some of the outstanding munitions difficulties. The sole cause of the urgency of the Bill now was the abolition of the leaving certificates. He might be asked why, then, he did not repeal them at once. The reason was that before the leaving certificates could be repealed another step had to be taken. Preparations for this were far in advance, but they could not be settled before the end of the session. Among the labour anomalies created by the war was that of highly skilled men working on time at comparatively low wages and seeing side by side newcomers not so highly trained, earning higher wages on piece work. If the leaving certificates were abolished before this anomaly remained unredressed, he was advised it might lead to a serious migration from the higher ranks of labour into the less highly skilled, though more highly paid, forms of industry. He had to ask the Committee to give him the means to provide against that.

The Director of the Department of Labour Statistics, dealing in *The Labour Gazette* on the state of the labour market in July, says that the previous high level of employment was maintained during the month, and much overtime was worked in many of the principal trades. There was some time lost on account of holidays, especially in Scotland. In Ireland there was some unemployment in certain trades.

The increases in rates of wages and war bonuses reported to the Department as taking effect in July affected nearly 400,000 workpeople, and resulted in a total increase of over 30,000*l.* per week. No decreases were reported. Changes in the textile trades accounted for nearly three-quarters of the total number of workpeople affected, mainly owing to an increase of 10 per cent. to operatives in the cotton weaving industry. Many increases were again reported in the building trade, and other important bodies of workpeople affected were ironstone miners and blast-furnacemen in Cleveland, iron and steel workers in South Wales and West Scotland, and tinplate workers in South Wales.

The number of disputes beginning in July was 48, and the total number of workpeople involved in all disputes in progress was 45,425, as compared with 25,767 in the previous month and 34,520 in July, 1916. The aggregate duration of all disputes during the month was 260,600 days, as compared with 192,700 days in June, 1917, and 118,000 days in July, 1916.

The average weekly number of vacancies notified to all Employment Exchanges for the five weeks ended July 13, 1917, was 36,904, as compared with 35,098 in the previous four weeks and with 39,154 in the five weeks ended July 14, 1916. The average weekly numbers of vacancies filled for the same periods were 28,822, 28,270 and 30,823 respectively.

Speaking in Parliament last Wednesday, Sir A. Stanley said he was aware that there was said to be a possibility of a stoppage among a certain section of engineers and firemen who belong to the Associated Society of Locomotive Engineers and Firemen, who, he understood, represent about one-half of the locomotive drivers and firemen, in order to compel the railway companies during the present war emergency to recognise the principle of an eight-hour day. After detailing the negotiations which had taken place since the war broke out and the improvements made in the men's wages, Sir A. Stanley added that after conference with the society's representatives and consultation with the War Cabinet, he stated on August 9 that the Government could not during the war consider the principle of an eight-hour day, as this was not a condition arising out of war conditions; nor could an eight-hour system possibly be worked during the war, and this was freely admitted by the men's representatives. The present system of railway control by the Government would continue for some time after the war, and there would then be an opportunity of raising and dealing with the question of hours. He could not believe that any responsible organisation of railwaymen, who had hitherto played such a splendid part in assisting the nation in its emergency, would jeopardise the prosecution of the war by authorising or taking part in a stoppage at this critical time. But he intimated, on behalf of the Government, that the necessary steps were being taken to deal with any emergency that might arise.

DIRECTORY OF ENGINEERS AND IRON, METAL AND ELECTRICAL TRADES.—The thirteenth edition of Kelly's Directory, for 1917, of the Engineers and Iron, Metal and Electrical Trades, throughout England, Scotland, Wales and the principal towns in Ireland, the Channel Islands and the Isle of Man, has now appeared. It is published at the price of 36*s.* by Kelly's Directories, Limited, 182 to 184, High Holborn, London, W.C. 1. It is divided as per counties and towns arranged alphabetically, followed by sections dealing with London, the country under trade headings, Ireland, &c. The book, like all Kelly's Directories, has been carefully got up, and will prove a useful book of reference in regard to the trades it covers.

NORWEGIAN SHIPPING.—During the first half of the present year the Norwegian merchant navy has been increased by 29 vessels, built within the country, and having an aggregate tonnage of 20,000 tons; whilst some 20 vessels, of an aggregate tonnage of 58,000 tons, have been built abroad—11 of these have been built in the United States, 7 in Holland, 1 in Japan, and 1 in Denmark. During the same period 18 old vessels, of an aggregate of about 10,000 tons, mostly sailing vessels having motor power, have been bought abroad. The decrease during the first six months has been very serious, amounting in the aggregate to 276 vessels with an aggregate tonnage of 418,000 tons, of which total only 29 vessels with an aggregate tonnage of 31,700 tons, have been lost through ordinary mishaps, the rest having been torpedoed or lost through collision with mines. The mercantile navy of Bergen has, during the last 10 years, increased from 326 vessels with an aggregate tonnage of 385,245 tons to 439 vessels with an aggregate tonnage of 567,655 tons. The net earnings of the Bergen fleet of tramp steamers, excluding those of the Bergen Steamer Company, amounted for 1916 to 104,000,000 kroner, against 47,700,000 kroner for 1915, 10,000,000 kroner for 1914, 12,400,000 kroner for 1912 and 7,200,000 kroner for 1911. (1 kroner = about 1*s.* 2*d.*)

THE NEW SWEDISH CHEMICAL INDUSTRIES BUREAU.—A Chemical Industries Bureau is being formed in Sweden. The plan of establishing a central institution of this kind, to deal with the Swedish chemical industries, which are gradually gaining great importance, dates back several years. Various circumstances have hitherto prevented the scheme from being given effect to. It is generally admitted that under proper management it will prove of material aid to the chemical industries of the country. As an instance, the Järnkontoret is adduced, this having proved of invaluable assistance to the development of the Swedish iron and steel industry. In this connection, reference is made to the Verein zur Wahrung der Interessen der chemischen Industrie Deutschlands, to which the German chemical industry owes much of its success and expansion of recent years, which other countries have found out to their cost. The chemical industry of Sweden within a comparatively modest span of years has grown into one of great magnitude, and a great amount of work is apparently awaiting the new central organisation. It is intended to bring together the Swedish chemical industrial interests, to watch happenings, changes and utterances within its domain, and to further all the special requirements of the chemical industry in its different branches.

THE AIROSTYLE PAINT-SPRAYING PLANT.

CONSTRUCTED BY THE AIROSTYLE AND LITHOS, LIMITED, LONDON.

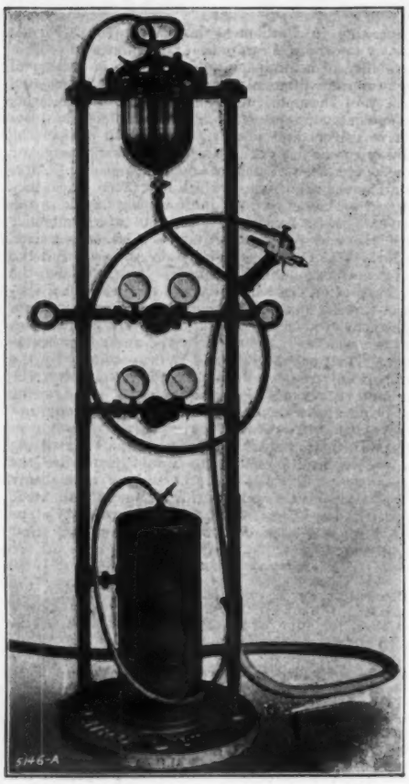


Fig. 1.

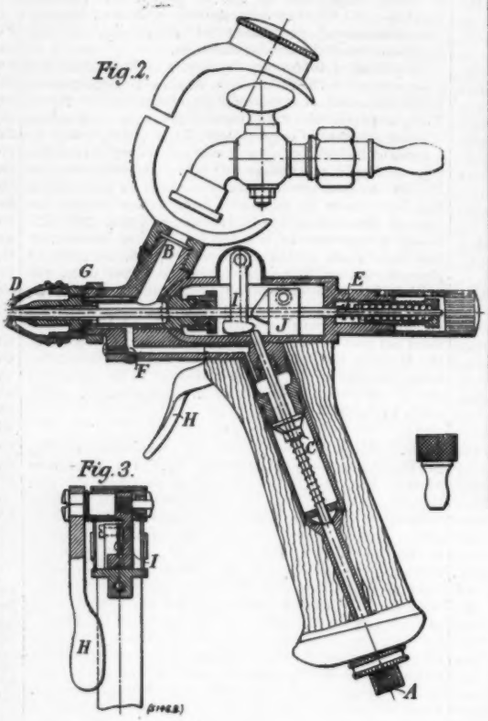


Fig. 4.

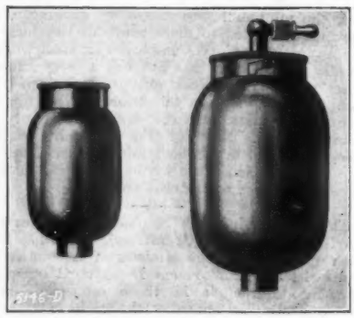


Fig. 5.

Fig.6. SECTION THRO' SHOP SHEWING HOODS &c.

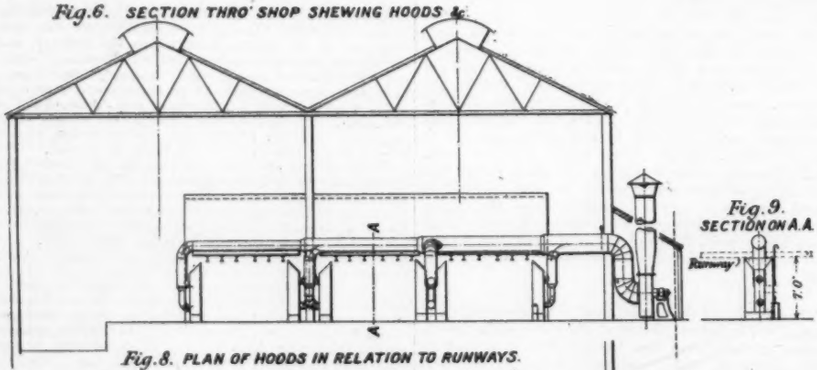
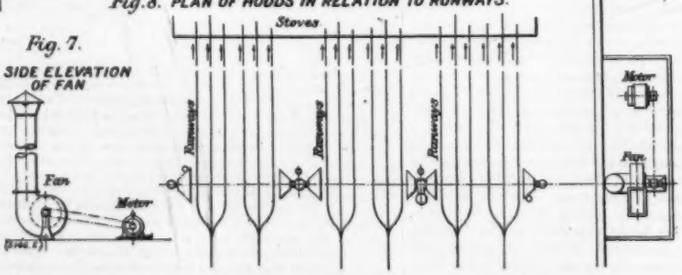
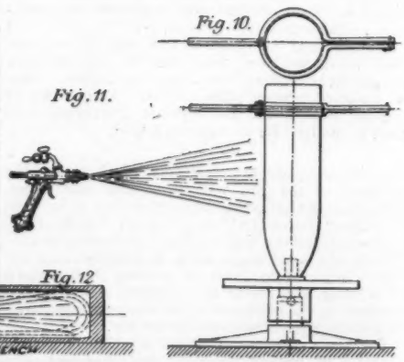


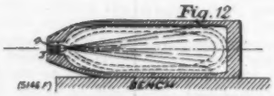
Fig.9. SECTION ON A.A.

Fig.8. PLAN OF HOODS IN RELATION TO RUNWAYS.

Fig.7. SIDE ELEVATION OF FAN







The application of paints, varnishes, japans and lacquers to surfaces of machine parts, electrical apparatus, constructional ironwork, motor cars, &c., became a serious problem as the output of munitions of every kind increased beyond the scope of all prior experience. Even had skilled painters been forthcoming in the numbers required, brush painting is at best a slow process, and reliance on it would have greatly impeded the supply of our forces at the front. The brush has, in many cases, been superseded by the spray, notably for aeroplanes, guns and armour, shell-painting and varnishing, fuse lacquering, painting of munition boxes, cartridge clips, and the application of service green to a multitude of parts required by the forces, in addition to such work as the japanning of motor-car and motor-cycle components; whilst the process has also been largely adopted for painting standard steelwork, and in some cases for machine tools.

On this and the opposite page we illustrate paint-spraying plants designed and made by the Airostyle and Lithos, Limited, of 35, St. Bride St., London, E.C.

The spraying unit is shown complete in Fig. 1. Its essential parts are the compressed-air receiver at the bottom, the paint-holder at the top and the spraying pistol. The compressed air is provided by any suitable compressor, the free air being drawn through a filter to remove dust, and then condensation traps, at convenient points in the air main, get rid of moisture before it enters the receiver of the spraying unit. The air enters the receiver here through an adjustable reducing valve, by means of which the operator can regulate the spraying pressure. An air pipe connects the paint-holder at the top of the unit with the second reducing valve, which is adjusted so that the effective pressure in the paint-holder is about one-tenth that used for spraying. The paint supply is thus, it will be seen, fed to the spraying pistol under

THE AIROSTYLE PAINT-SPRAYING PLANT.

CONSTRUCTED BY THE AIROSTYLE AND LITHOS, LIMITED, LONDON.

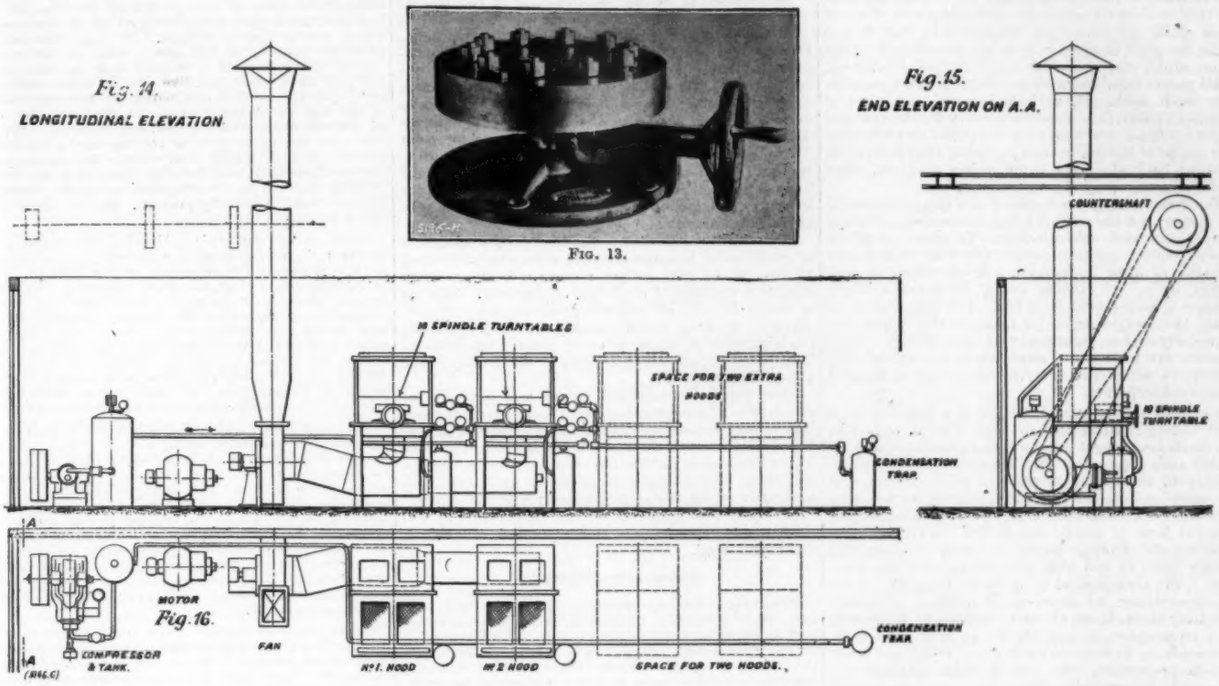


FIG. 13.

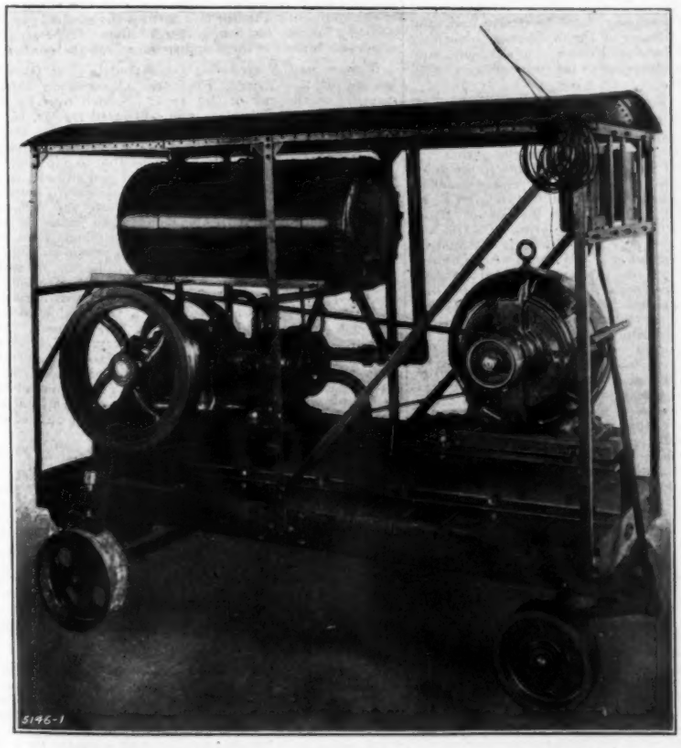
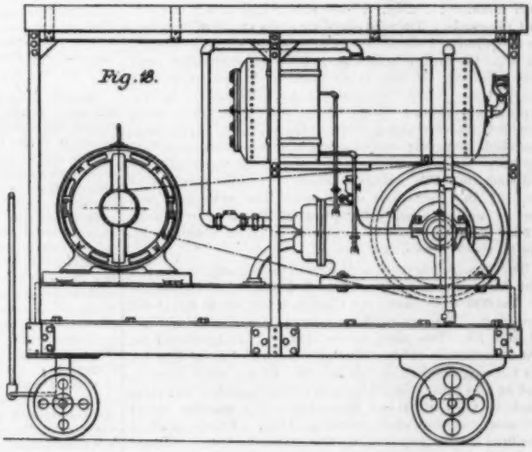
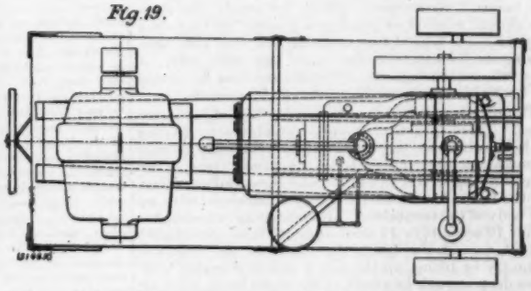


FIG. 17.





pressure—a feature which makes it possible to operate the sprayer with any kind of oil paint. With water washes and varnishes, which are less viscous, the pressure feed may be dispensed with, but less surface will be coated in a given time.

The spraying pistol is shown to a larger scale in Fig. 4, and sectional views of it are reproduced in Figs. 2 and 3. The air supply enters at A and the paint at B, the former is controlled by the spring-loaded, flat-seated valve C, which makes joint with a fibre ring as indicated. A needle valve D controls the supply of pigment, and is kept closed when the pistol is not in use by the spring shown at E. The air reaches the spraying jet through the passage F and the ring of holes indicated at G, whilst the paint is fed centrally. Both valves C and D are controlled by the trigger, which, as best seen in Fig. 4, operates a swinging cam I. On pulling the trigger this cam first depresses the spindle on which the valve C is mounted and next pushes back the needle D, by means of the cross-head J. An adjustable stop, best seen in Fig. 4, limits the motion of the trigger H, and hence the opening of the paint valve. The needle D passes through a leather-packed stuffing-box, which prevents

the escape of paint in the wrong direction. The operation of painting is very rapid, as much as 7 sq. yards of a plain surface having been painted in 1 minute. For certain small work the pistol may be operated without the accessories illustrated in Fig. 1. Small containers are then mounted directly on top of the pistol. Two of these small containers are illustrated in Fig. 5, one being designed to operate with air pressure above the paint, whilst with the other a gravity feed is relied on.

All paints have, the makers inform us, been successfully dealt with. If, with bad paint, any signs of clogging appear, it is merely necessary for the operator to put his finger over the end of the pistol for a moment. The escape of the compressed air being thus prevented, it blows back along the paint supply channels, effectually clearing away the obstruction.

The makers supply not merely the spraying apparatus proper, but the whole of the accessories, including compressors and exhaust fans. To clear away all fumes from the workman, where the work is small the painting is done underneath a hood, which is connected up to an exhaust trunk in which a slight vacuum is maintained by a fan. For larger work, to which the sprayer must be taken, either a portable electrically-driven compressor is provided or high-pressure air mains are established throughout the factory, to which the spraying units can be coupled at convenient points.

A typical arrangement installed at a large national shell factory is illustrated in Figs. 6 to 9, page 170. The shells are brought up on overhead runways, and are in this case painted as they hang, and are passed on directly to the drying stoves. In point of first cost the most economical method, however, is to carry the shells on a small turntable, and with a simple and practical form of handle-clip (which also serves as a mask for the driving band) the shell is easily and quickly lifted to and from the carriage and the turntable. The arrangement is shown in Figs. 10 and 11. The time taken to spray-paint a shell is almost incredibly short, being about 12 seconds to 15 seconds for a 60-pounder, 35 seconds for an 8-in., and from 70 seconds to 80 seconds for a 12-in. shell, and other sizes in proportion. To varnish them satisfactorily and most economically from the point of varnish consumption, there is an even greater gain in time; 6-in. shells take 4 seconds to 6 seconds; 8-in., 6 seconds to 8 seconds; 9.2-in., 10 seconds; 12-in., 12 seconds to 15 seconds. There is absolutely no waste of varnish, as the whole of the delivery is into the shell, as shown in Fig. 12, and practically none of the varnish runs out. Indeed, an important point to be noted is that much less trouble is experienced afterwards in re-tapping the threaded nose of the shell than when other methods of varnishing are employed. In varnishing, the shell is merely rolled along the bench, thus obviating the wearisome business of tipping up the shell and pouring out the varnish, where the older method of pouring the varnish is in vogue. The spraying process is unhesitatingly accepted by the authorities as giving coatings in no way inferior to those obtained by the methods previously in use.

The spraying system is also used for coating fuse parts. The Airostyle and Lithos, Limited, state that an output of 200,000 fuse parts per operator per week has been recorded. A plant for four operators is shown in Figs. 14 and 15. The parts to be sprayed are mounted on ten-spindle turntables, illustrated separately in Fig. 13. On turning the handle shown the whole table rotates, and at the same time the individual spindles are also made to turn at about three times the angular speed by means of sun and planet gearing. Every part of the fuse is thus exposed to the spray in turn. Hoods and exhaust mains, arranged as shown, carry away all the fumes. Some works adopt for small flat rings the simple method of placing a number of these in a tray having a hinged top, spraying one side first, then closing the lid and reversing to do the other side. A tray full, containing, say, 20 to 30, can thus be coated on both sides in about 25 seconds to 30 seconds.

The rotary turntable is, however, adopted for larger fuses. These are carried on a circular tray having 10 holes which are too small to allow the fuses to pass through, but large enough to let the spindles pass. The tray is dropped over the table, and the spindles, rising, lift the fuses clear, whilst the tray meanwhile rests on the body of the turntable. After spraying (which takes about 10 seconds to 12 seconds for 10 fuses, practically only 1 second per fuse), the whole 10 are removed instantly by lifting up the tray; this is provided with sides deep enough to admit of the trays being stacked, so that it is quite simple to handle the fuses without having to take them out of the trays at all. Where square trays are already in use, holding 10 or 12 fuses, the practice is to lift the fuses out and place them on the turntable, one by one, replacing them after they have been lacquered. Even with this time-losing arrangement one operator can deal with about 100,000 fuses per week. The turntables are usually rotated by hand, although means can be provided for driving them by power. The finish obtained is said to be far superior to a brush finish, and is coupled with a big saving in time and, in many cases, an economy in lacquer.

An interesting further development of the process is that of portable painting plants capable of dealing with the periodical painting of ships, large buildings, bridges and other structural work. The whole compressor plant is mounted complete on wheels, as illustrated in Fig. 17, and by an elevation and a plan in Figs. 18 and 19. This set, it will be seen, is electrically driven, and has been specially designed and built for Admiralty purposes by the makers. The compressor is coupled to the motor by a belt and delivers air to the receiver fixed above at a pressure of 60 lb. Air from this receiver is carried through flexible metallic tubing to several sets of painting apparatus of the type already described.

On test, the set above referred to showed a maximum or peak load of 10 amperes at 214 volts when delivering 15 cub. ft. of free air per minute into the receiver against a pressure of 80 lb. per square inch. This set is easily capable of delivering air to three or four painters working simultaneously on large surfaces, enabling each of them to cover some 4 sq. yards to 7 sq. yards per minute, according to the density of the material employed.

Spraying is also employed in the textile trades for decorative effects on calico, &c. (many important and interesting mechanical devices being employed in conjunction with such work, both for handling the work whilst in progress and for the after development of the decorative effects obtained), as also on wall papers, and for whitewashing, distempering and mural stencilling.

It may be possible for us, in some future issue, to deal further with this subject, the importance of which is daily increasing.

Personal.—Korting Brothers, Limited, have now gone into voluntary liquidation for the purpose of getting rid of all enemy connections. With the consent of the Government authorities a new company, under the title of Korting Brothers (1917), Limited, has been registered, and has taken over the business of engineers, previously carried on by Korting Brothers, Limited, at 53, Victoria-street, Westminster. The entire assets and goodwill of the old company have been acquired, and the new company will carry on the business with entirely British capital and under British management, and will develop the manufactures so far supplied by the old company in England.

Motor Gasolene Specifications.—So loose a use has been made of the term "gasolene" in the many recent researches on petroleum and cracking that the attempt of the United State Bureau of Mines to lay down specifications and rules for the testing of motor gasolene will be welcomed. Technical Paper 166, drawn up by E. W. Dean, deals with the subject. The Bureau of Mines began to collect information in the spring of 1916, and soon found out that few purchasers had any satisfactory standards for gasolene, and that the specifications extant were mostly incomplete or unreasonable. At the same time the fact that many refiners are cutting "deeper into the crude" to meet the increased demand for gasolene makes specifications particularly desirable. The three types of American gasolene are: "Straight" refinery gasolene, generally low in unsaturated and in aromatic hydro-carbons, and possessing a distillation range free from irregularities; blended casing-head gasolenes (the "straight" would be too volatile for general use), richer in constituents of low and of high boiling-points than in intermediate products, though the blending may make the distinction difficult; cracked or synthetic gasolenes, varying in the percentages of unsaturated and aromatic hydrocarbons, which, when present in moderate proportions, would not decrease the value of the gasolene in proper engines. In view of the variable conditions to be met, including also the different climates of various parts of the country, general numerical limits can hardly be fixed. The colour is of interest chiefly as an index of other qualities; gasolene should be colourless, and also free from rank odour; water and other foreign matter likely to produce sediment should be absent; to test for acidity the gasolene is shaken with water, which is then examined with litmus paper. The chief test, distillation by a method described (that of the American Society for Testing Materials) should yield certain fractions within certain temperature ranges. The temperature should not be below 158 deg. F. (70 deg. C.) when 20 per cent. of the gasolene has been distilled, nor be above an upper limit varying with the conditions of use; similar temperatures should be fixed for the distillation of 90 per cent.; the temperature reading for 50 per cent. should not be higher than half-way between the marks for the 20 per cent. and the 90 per cent. limits; the dry point is not to exceed the 90 per cent. reading by more than 99 deg. F. (55 deg. C.). The distillation test is to be made with 100 cub. cm. of gasolene. It will be seen that a density test is not stipulated, though it is frequently the chief criterion relied upon; the density is helpful when the source and production of a gasolene are known, but in itself of slight significance. The relations between the calorific power and usefulness of a gasolene are not sufficiently studied; but gasolenes of widely differing properties may differ very little in calorific power.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Scotch Steel Trade.—The additions and improvements to local steel-making establishments, which were so satisfactorily carried through during the Glasgow Fair holidays, are already responsible for the growing output which was so greatly desired. In every direction the mills are running at full speed, steel on Government account being as much in request as at any time during the past three years, for, like various other trades, the steel industry is still dominated by the requirements of the war to so great an extent that no other class of business receives the slightest consideration. Perhaps the most urgent demand at the moment is for certain sections of high tensile steel rounds, for constructional material generally, and for ship plates and the various sections required in the shipbuilding yards, where the greatest possible activity prevails. Except where fixed, prices all remain firm.

Sulphate of Ammonia.—Already the question of sulphate of ammonia as a fertiliser for the crops of 1918 is engaging the attention of the Scottish Board of Agriculture, and it has been intimated that unless farmers place their orders by September 1 it will be impossible to guarantee the requisite supplies for use next spring. Attention to this notice will ensure not only a sufficient quantity, but also an equitable allocation among the various agricultural districts of the country, because, as was made very clear at a meeting in Edinburgh on Friday last, the entire home production of sulphate of ammonia is now being reserved for home use.

Malleable Iron Trade.—There is no falling-off in the demand for malleable iron, and in every direction makers find themselves as busily occupied as it is possible for them to be, and this notwithstanding the fact that many of the mills are now employed turning out large quantities of steel sections suitable for military purposes. Nothing further has as yet transpired with regard to a systematic allocation of the malleable iron output to fit in with the demands of ordinary mercantile consumers, whose business has been in not a few instances crippled through want of available material. "Crown" bars remain steady at about 15*l.* 5*s.* per ton and upwards, according to brand.

Scotch Pig-Iron Trade.—Alike in the production and disposal of pig-iron of all grades, a particularly systematic method now prevails. The output of hematite has been increased to keep pace with the ever-increasing demand for urgent Government purposes. Government control has certainly improved conditions, and the elimination of the competitive factor now insures the earliest possible delivery for the most important orders. The scarcity of certain brands of forge and foundry iron still continues.

Glasgow and Engineering Development.—The Glasgow branch of the British Engineers' Association held a meeting at the end of the week, presided over by Mr. Peter Denny, Dumbarton, and addressed by Mr. H. R. Summers, London, who detailed at considerable length the aims and objects of the association. As secretary of the association Mr. Summers was able to explain that the main idea was the encouragement and support of all schemes destined to cultivate good relationships between employers and employed, and between the different societies connected with the engineering industry, and not merely the dealing with labour problems pure and simple. By promoting co-operation in regard to buying, selling and shipping, the association hoped to assist all those engaged in the industry, and by encouraging technical education and research work, it was expected that the association might prove a very valuable link between the manufacturer and the expert. The standardisation of plant and machinery, the acquiring of useful information regarding overseas trade, the furtherance and improvement of financial arrangements for overseas trade, and the movement in favour of the establishment of a Ministry of Commerce, were all matters which, the speaker said, would receive the immediate and careful attention of the new body.

Tungsten Thermo-Couples.—The thermal electromotive force curve of tungsten is somewhat unusual, in so far that its inversion temperature occurs at about 40 deg. C. Other combinations, which have an inversion temperature near 0 deg., are cadmium-iron at 170 deg. and copper-zinc at about 30 deg. C. For temperatures below — 100 deg. C. the thermo-electric power relatively to copper is about 3.5 microvolts to 4 microvolts per degree, whilst above + 200 deg. C. the thermo-electric power is about 4.5 microvolts per degree, so that tungsten shows no apparent advantage in thermo-electric work.

Treatment of Nickel Steel.—Mr. S. W. Parker, of the Testing Department, Bethlehem Steel Company, Steelton, Pa., has conducted experiments with two qualities of nickel steel, showing the following analyses: (*a*) 0.22 carbon, 0.011 phosphorus, 0.38 manganese, 0.028 sulphur, 0.12 silicon, and 3.16 nickel; (*b*) 0.41 carbon, 0.033 phosphorus, 0.55 manganese, 0.049 sulphur, 0.14 silicon, and 3.40 nickel. He has found, reports *The Iron Age*, that the best combination of physical properties is obtained in the 0.22 per cent. carbon steel by annealing at a temperature ranging between 1,400 deg. and 1,450 deg. F. For the 0.41 per cent. carbon steel the best combination of physical properties is obtained by annealing at between 1,350 deg. and 1,450 deg. F., the minimum temperature being therefore lower than in the 0.22 per cent. carbon steel. The results of the researches have been repeatedly checked in practice and the general conclusions are being applied in the annealing of forgings of all sizes.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—The resumption at pits, both in South Yorkshire and North Derbyshire, was much better than was generally anticipated, and the outcome is a much-wanted easing of a position which was becoming far too difficult for the peace of mind of consumers. Hard coal pits, working at a maximum pressure since a week ago, have now wiped off many arrears which had accumulated on contract accounts, and are keeping abreast of orders. This in itself is no mean achievement, though works, blast-furnaces, and railway companies are displaying eagerness and anxiety with regard to winter reserves which tends to make the position of collieries one of some difficulty. Best steams are hard to get on the open market. Slacks remain weak. Gas fuel goes away on account of contracts to inland works at a good figure, but there is little passing for export. There is no great change in the house-coal position, where the chief feature is the bid for winter stocks. Quotations :—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best Silkstone, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire best brights, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire house coal, 17*s.* to 18*s.*; best large nuts, 16*s.* 6*d.* to 17*s.* 6*d.*; small nuts, 15*s.* 6*d.* to 16*s.* 6*d.*; Yorkshire hards, 16*s.* 6*d.* to 17*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; and smalls, 7*s.* 6*d.* to 8*s.* 6*d.* per ton at the pit.

Iron and Steel.—Activity prevails in all branches of Sheffield trade. The effect of the holiday stoppage is found in the present smooth running of all works, for both the workers and the plant have benefited. New equipment has been installed in cases almost too numerous to mention, whilst the exhaustive policy of overhauling which has been systematically carried out by all the controlled shops has been attended with the most beneficial results. The holiday, however, is not regarded as a sign that the demands for war work of any description are lessening. The need is as imperative as ever, judging by the manner in which the various Government specifications grow in size and volume, but it was found that in the interest of the workers' health and the conservation of plant a rather long stoppage was inevitable. The opinion is freely vented that the break was a wise move, and certainly the refreshed and reinvigorated war-workers are concentrating upon their tasks with energy renewed and faith undimmed. Government contracts absorb more and more the Sheffield production of steel. This is almost solely of the acid variety. It may be within the recollection of readers of these notes that at the request of the Ministry of Munitions the Sheffield steel makers concentrated upon acid steel, and elsewhere efforts were simultaneously made to expand the basic brand. The Sheffield scheme has so far answered exceedingly well, and even promises better for the future, but difficulties have arisen with regard to the development of the basic scheme. An essential was a great increase in the production of basic pig-iron. At the time it was considered the Government would be well advised to arrange for the working of numerous idle furnaces, but the labour problem probably led to the adoption of the easier course of changing forge and foundry furnaces to basic. Now there has arisen some shortage of the other two brands. Tramway works are busy with renewals and repairs, and railway orders have arrived for springs, axles and tyres. Large parcels of high-speed and carbon tools are going away to the important shipyards on Government account, and the various shops are working overtime consistently to fulfil large indents. Cutlery firms are in a dilemma. They have more orders on hand than they have either material or labour to deal with, and in most cases are sharing their output equally amongst their numerous customers, always giving overseas trade the first call. Plate makers and silversmiths are also busy. The general level of foreign and colonial custom is fully up to expectations.

Electricity Development.—An important scheme will be submitted to the Sheffield City Council to-day for confirmation. Already this body has adopted a 2,000,000*l.* scheme to supply an ample quantity of cheap electric current after the war, but with the pressing needs of to-day it has been found necessary to formulate an emergency policy at a cost of 560,000*l.* Negotiations with the Ministry of Munitions have resulted in the proposed transfer to Sheffield of a 28,000-kw. plant, and this is to be installed at the emergency power-house on the Blackburn Meadows site. The corporation is also to place contracts for the necessary machinery, boilers and works.

JAPANESE HONOURS FOR NAVY ENGINEERS.—The following Orders have been awarded, among others, to engineering officers of the Royal Navy by His Majesty the Emperor of Japan :—Sacred Treasure, 3rd Class : Engineer-Commander William John Duffell, Engineer-Commander Walter Rudolph Parnall, and Engineer-Commander George Roussel Byles.

METAL FAMINE IN GERMANY.—It is stated that the firm of Franz Schilling and Sohn, bell founders to the Court, at Apolda, Hannover, have smelted down some 70,000 church bells during the war, the metal of which has been used for military purposes. The famous Kaiserglocke from the Cologne cathedral, cast from cannon taken from the French during the Franco-German war of 1870–71, will, it is further said, also be removed for the same purpose. Lightning conductors, rumour also states, are being pulled down from the churches, and their metal used for army requirements.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—All descriptions of Cleveland pig-iron are quite plentiful. Excellent, regular working of the furnaces keeps the output of the better qualities high, and the production of forge iron proportionately low. The latter is in much better demand than it was a little while ago, and stocks of forge iron, which were rather high, have now been brought within narrow proportions. Local demand for Cleveland pig-iron has slackened considerably, due to next week's race holidays, when many consuming works will be closed, but a fair amount of buying for Scotland continues, and deliveries to customers across the border are going forward very freely under the August allocations. Some improvement in foreign trade is reported, and with expectation of more tonnage becoming available further expansion of business with the Continent is looked for. French requirements are being substantially covered, but much larger quantities would readily be taken by Italy. For home consumption No. 3, No. 4 foundry and No. 4 forge all stand at 92*s.* 6*d.*; and No. 1 is 96*s.* 6*d.*; whilst for shipment to France and to Italy No. 3 is 102*s.* 6*d.*, No. 4 foundry 101*s.* 6*d.*, No. 4 forge 100*s.* 6*d.*, and No. 1 107*s.* 6*d.*

Hematite Iron.—In the East Coast hematite department there is continued absence of new features. Strict official supervision of distribution enables all legitimate home needs to be adequately met, and leaves some little surplus iron for sale abroad, but new foreign business is very difficult to arrange, and export quotations are all but nominal. Meanwhile shipments to our Allies, against old contracts, are proceeding on a scale which, though below what could be desired, may, under the conditions prevailing, be regarded as fairly satisfactory. Occasional new home sales are recorded. Nos. 1, 2 and 3 are 122*s.* 6*d.* for home use, 137*s.* 6*d.* for shipment to France, and 147*s.* 6*d.* for export to Italy.

Output of Pig-Iron.—Production of pig-iron has recently been reduced by the blowing-out of two blast-furnaces—one on Cleveland pig-iron and the other on hematite iron—for very necessary repairs. Thus the number of furnaces in operation in the north-east district becomes 75, of which 34 are turning out Cleveland pig-iron, 27 are producing hematite, and 14 are manufacturing special kinds of iron. One or two idle furnaces may be blown-in in the near future.

Manufactured Iron and Steel.—Huge requirements of the Government, and the very large and still-increasing demands of the shipyards, keep manufacturers working at high pressure. With almost the whole of the output taken up by these needs, very little opportunity is afforded for the transaction of business in the ordinary way of commerce. Exports are almost entirely restricted to loadings for the Allies, very little material now going to oversea British possessions. Quotations keep steady. To home consumers common iron bars are 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; double best bars, 14*l.* 10*s.*; treble best bars, 14*l.* 17*s.* 6*d.*; iron ship plates, 15*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 18*l.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 20*l.* and upward; steel boiler plates, 12*l.* 10*s.*; steel joists, 11*l.* 2*s.* 6*d.*; steel strip, 15*l.* 10*s.*; heavy sections of steel rails, 10*l.* 17*s.* 6*d.*; packing iron and steel (parallel), 13*l.*; and packing iron and steel (tapered), 15*l.* 5*s.*

Coke.—Heavy local demand for coke is met by very ample supply. Medium blast-furnace kinds still realise the fixed maximum of 28*s.* at the ovens, and qualities low in phosphorus remain at the limitation figure of 30*s.* 6*d.* at the ovens.

ASPHYXIATION BY BLAST-FURNACE GAS.—Danger from blast-furnace gas, that is, chiefly from the 20 per cent. or 30 per cent. of carbon monoxide in it, threatens everywhere near blast-furnaces, below, near the boshes and bustle pipe, above, at the top, along the pipes to the hot blast stoves, gas mains, boiler-house, gasholders and blowing engine (when gas-driven), and the danger is the greater the purer, *i.e.*, the more free from smell and visible dust, the gas is. There are no warning symptoms, or they come too late at any rate. A man who has spent some time with apparent impunity in an air containing a little CO (less than 0.1 per cent. or 0.05 per cent.) may be overcome by a slight rise in the percentage and be rendered helpless, especially when on a gallery or stairway, or in an exposed position. Discussing this question in Technical Paper 166 (66 pages) of the United States Bureau of Mines, Frederick H. Willcox refers to a great many fatal or serious accidents, although he does not at all desire to exaggerate the dangers. He finds that only 14 per cent. of the fatal, and 4 per cent. of the non-fatal, accidents at blast-furnace plants are due to asphyxiation; but the accidents are too frequent, especially during repairs and temporary interruptions. To avoid them the plants should be well-designed and supervised and well provided with helmets and breathing apparatus, &c. Too many danger signs defeat their object. Certain operations should never be done by one man; often two men, with a third to watch them from a safe place, may be required. Access to the top and to the bustle pipe, to the gas-house, blast valves, &c., he would only give by doors under lock or fitted with automatic signals; railings he would make high and substantial enough to really prevent a man from falling; on the furnace top he would place an emergency stretcher for lowering an asphyxiated man with the aid of tackle. Several of the safety devices for valves, &c., illustrated have found adoption.

NOTES FROM THE SOUTH-WEST.

Cardiff.—The relative shortage in supplies continues, and coals of practically all large descriptions are unobtainable for ordinary export. The authorities are commandeering heavily, and tonnage supplies are quite sufficient to absorb the coals that are coming down from the collieries. Several important meetings have been held on 'Change this week relating to shipping, pitwood and brokerage questions, and these have occupied the chief attention of members. Shipowners have been concerned chiefly over the terms of the Government's new war risks insurance scheme, and they are in a state of much apprehension as to the basis of valuation which will be adopted. They are unanimous in the view that the old Admiralty basis of original cost less 4 per cent. depreciation plus 50 per cent. is utterly impracticable, but are uncertain as to whether the Admiralty intend to adhere to that basis or to pay on the market value of lost tonnage. The shipbrokers considered a communication from the Controller of Shipping in regard to brokerage services in connection with certain neutral tonnage. They have repeatedly protested against the action of the Government in putting controlled tonnage of this character under the exclusive management of shipowning firms, and it is stated that there is now a possibility of a change favourable to ship-brokers. They have accordingly forwarded to the Controller a list of local firms to whom such tonnage should be allocated, and the hope is entertained that ship-brokers will in future receive from the shipping authorities more considerate treatment than they have done during the past twelve months. The matter of the classification of coals is also attracting renewed attention. There are general complaints at the long delay in the announcement of the scheme of classification, and it is now understood that this delay is likely to continue for some days at least. The original list has been altered, and Swansea coals have now eight or nine grades instead of four. The smalls have been graded lower, and through coals have been reduced from 25*s.* to 23*s.* 6*d.*

Newport.—There has been no change in the state of the coal market this week. Current outputs are being almost entirely absorbed by the authorities, and as shipping and empties are in good supply the collieries are working full time. There has been no other feature. Pitwood continues to be easy at 69*s.* per ton.

Miners for the Army.—The scheme for the combing-out of colliery workmen for the army has again been modified, and recruitment thereunder has been suspended. It was, therefore, decided by the Executive Committee of the South Wales Miners' Federation, on Wednesday, to postpone taking the projected ballot of the workmen until after the conference of the Miners' Federation of Great Britain.

AMERICAN–SIBERIAN STEAMSHIP CONNECTION.—It is stated that at the instance of an enterprising Norwegian, Mr. Jonas Lied, who has been very active in the development of North Siberia shipping, a steamship connection is to be established between American ports and Siberia during the months of August and September. The route will be via the Kara Sea, and the steamers are to discharge at the mouths of the Obi or the Yenisei, from where the goods will be transported up the rivers in lighters and sloops.

SOUND PROPAGATION FROM THE EXPLOSION OF JANUARY 19, 1917.—In an article on the "Propagation of Sound and Zones of Silence," which appeared on page 532 of our issue of June 2, 1916, we commented upon the peculiarities of the transmission of sound waves from explosions. Dr. C. Davison has collected information on the audibility of the explosion which occurred in the East of London at 6.51 p.m. on January 19; he describes the results of his inquiry in *The Quarterly Review* of July. The report was heard in two areas roughly parallel to one another, separated by a broad belt of silence. The first area, which he calls the "inner" area—rather an unfortunate term—comprised the seat of the explosion, and extended mainly north-west, to Northampton, 66 miles from London, and south-east to Canterbury, 48 miles; the sound did not travel far north or south, the area having a width of about 20 miles only; due west the explosion was heard at Windsor and Ascot, however. The much larger "outer" area (about 5,000 sq. miles) had somewhat the same axial direction, nearly north-west to south-east, reaching from Nottinghamshire and Stow, 128 miles from London, and Lincoln to Norfolk (95 miles), the Norfolk coast, and beyond the coast; the length of this area was 131 miles, its width 44 miles. The distance between the two belts, *i.e.*, the width of the intermediate zone of silence, increased from 28 miles in the north-west to 48 miles in the north-east. Ipswich was in the zone of silence, being 10 miles from the outer area; one observer heard something, however. In the inner area people distinguished one or two reports, in the outer mostly three or four; the noise was that of a deep boom, followed by a rumbling, all being over within two or three seconds; in the zones of silence some windows rattled, but no real report was heard. In the inner area the report was heard either before or after windows had been shattered. The surface wind was not strong, from north-east or east; full meteorological information was not available, but it would appear that the wind deflected the surface waves upward into the air, the sound waves leaving the ground earlier or travelling up higher before descending again (in the outer area) than the inaudible air waves. Dr. Davison received 592 replies from 391 places, and made special inquiries as to the zone of silence.

COAL-HANDLING PLANT AT DURBAN.

CONSTRUCTED BY MESSRS. FRASER AND CHALMERS, LIMITED, ENGINEERS, ERITH.

(*For Description, see Page* 165.)

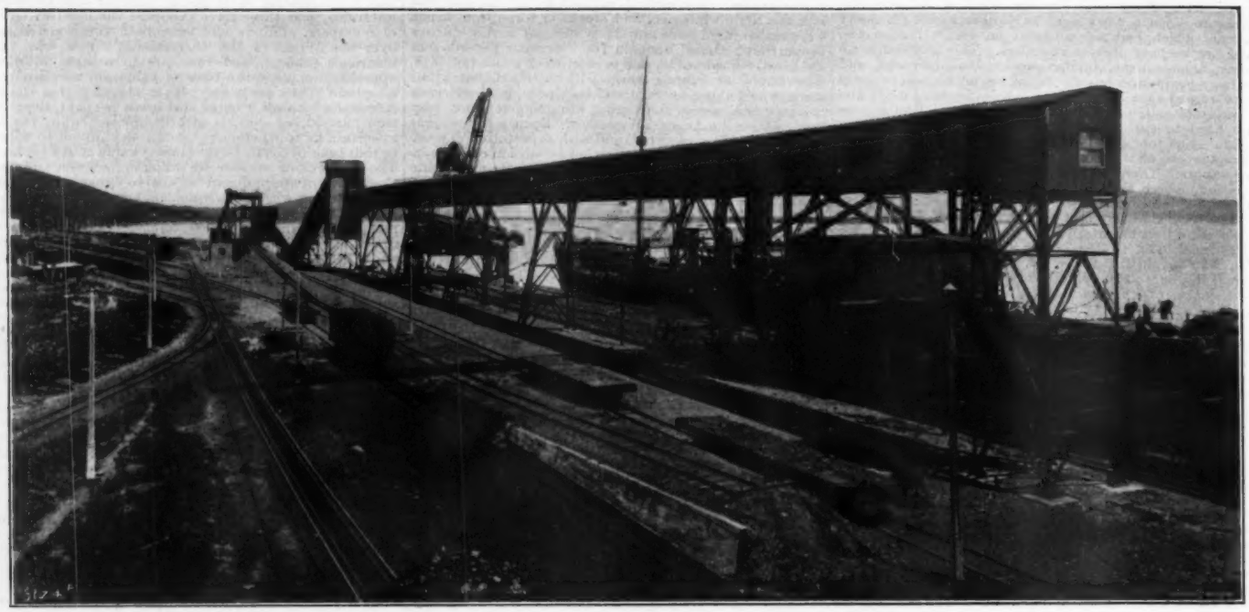


Fig. 8. Tripper Conveyor and Gantry.

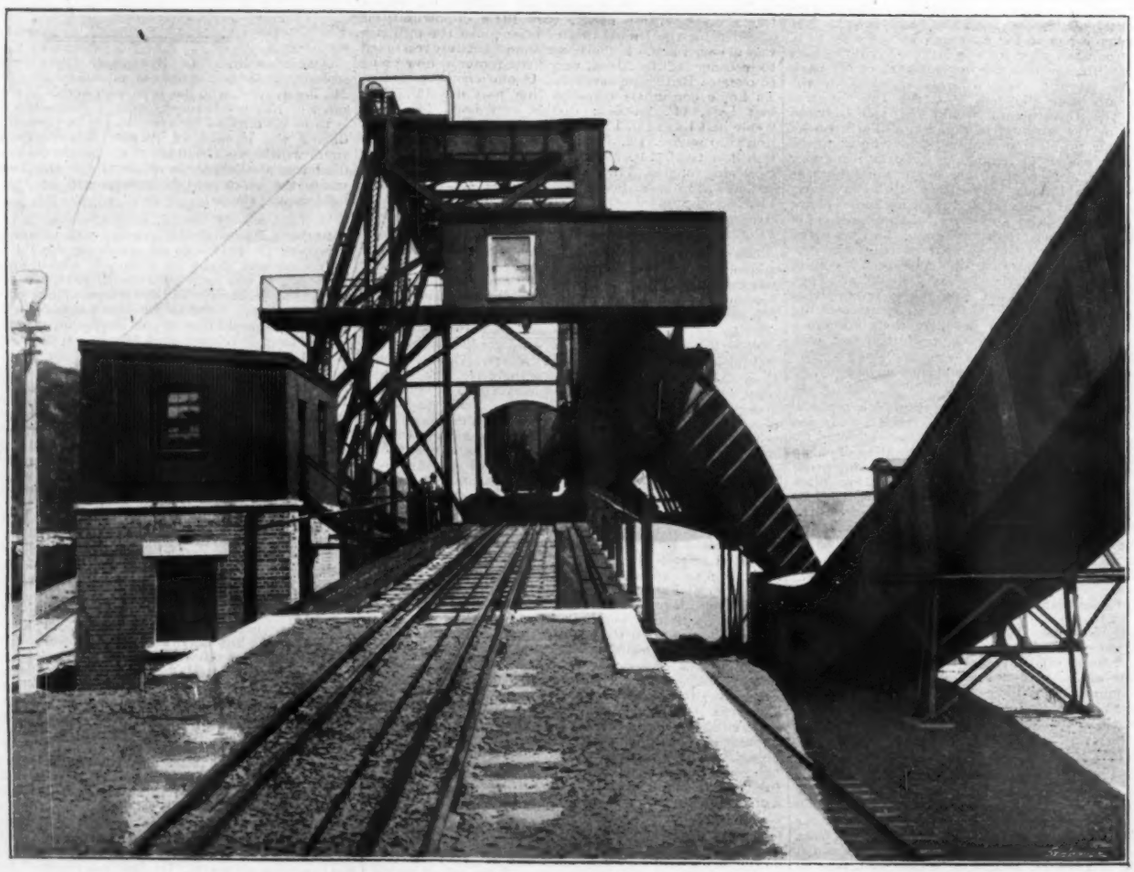


Fig 9. Car Dumper and Concentrating Pan.

COAL-HANDLING PLANT AT DURBAN.

CONSTRUCTED BY MESSRS. FRASER AND CHALMERS, LIMITED, ENGINEERS, ERITH.

(*For Description, see Page* 165.)

Fig. 1.

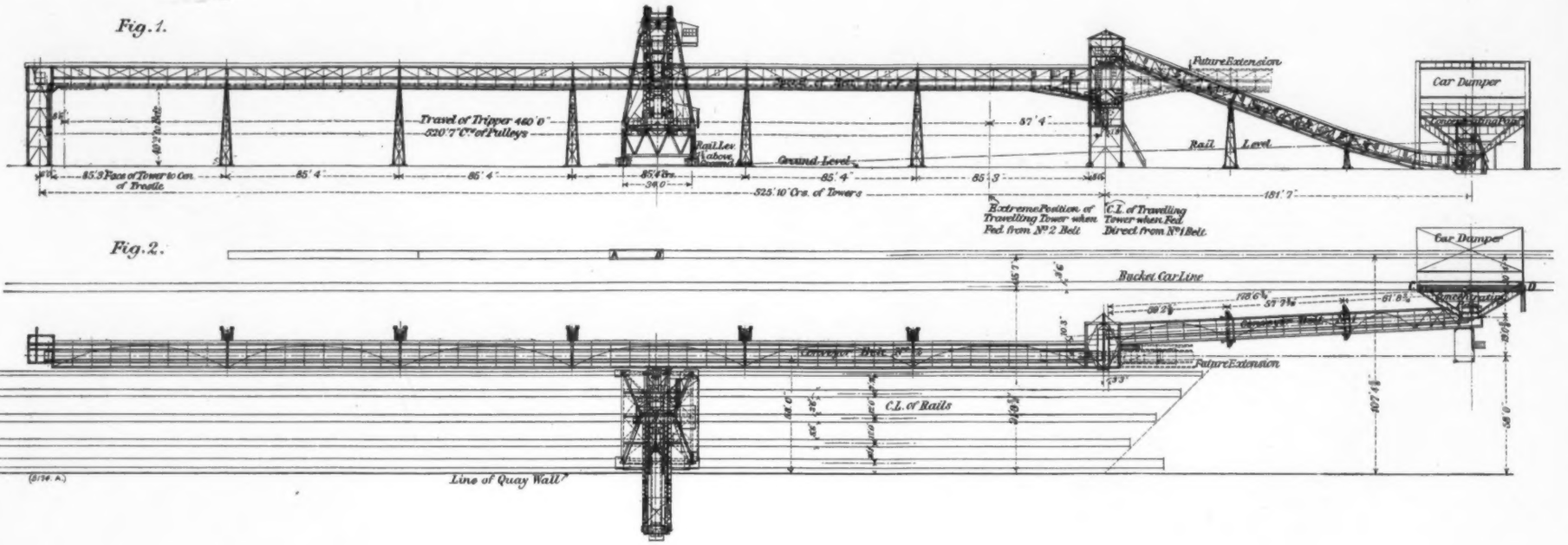


Fig. 2.

Fig. 3.

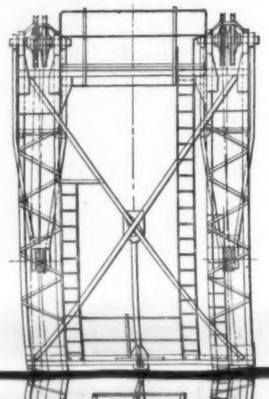


Fig. 4.

Driver's Cabin
Highest Working Position
Horizontal Jibe
Lowest Working Position
D'
E
F
C
(Side a)

Driver's Cabin
(Side c)

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CONTENTS.

	PAGE
On the Effect of Wake-Stream in the Case of Single-Screw Steamers (*Illus.*)	163
Coal-Handling Plant at Durban (*Illus.*)	165
Industrial Notes	168
The Airostyle Paint-Spraying Plant (*Illus.*)	170
Notes from the North	172
Notes from South Yorkshire	173
Notes from Cleveland and the Northern Counties	173
Notes from the South-West	173
The Training of the Future Citizen and Worker	175
Expenditure on War Munitions	176
Industrial Councils and the Garton Memorandum.—No. II	177
Ferro-Concrete Vessels (*Illus.*)	179
Notes	179
Literature	180
Books Received	181
Fuel Economy	181
Corrosion of Condenser Tubes	182
Wanted: A National Association of Engineering Foremen	182
Multiple-Arch Dams on Rush Creek, California (*Illus.*)	183
Colonial and Foreign Engineering Projects	186
Catalogues	186
ENGINEERING Patent Record (*Illus.*)	187

With a Two-Page Plate of the COAL-HANDLING PLANT AT DURBAN.

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal from 6d. to 8d. per copy. This increase dated from and included the issue of Friday, March 16. The change will not apply to unexpired subscriptions.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, AUGUST 17, 1917.

THE TRAINING OF THE FUTURE CITIZEN AND WORKER.

FOR some considerable time past the suitability of the education provided in the primary and secondary schools has been seriously questioned by all thinking men, and not least by the technical and administrative heads of large industrial concerns. That the products of the schools under present conditions are in the main unsatisfactory and the efficiency of the educational system low is proved by the experience of large employers of labour, by the number of committees which have investigated the present-day educational methods, and by the isolated efforts at reform and improvement made by private enterprise. Not only in the provision of a sound groundwork of knowledge upon which future education may be securely built, but also in the inculcation of the essential virtues which make for good citizenship and for efficient individual and corporate action must the present-day educational system be held to have fallen far short of the desirable standard.

It is therefore of especial interest to note the general trend of the proposals for the improvement of education outlined by Mr. Fisher, President of the Board of Education, in introducing his Education Bill in the House of Commons on Friday last. It is safe to say that no proposals put forward since the institution of compulsory school attendance have approached those contained in the present Bill in their potentialities for the future good of the individual and of the nation. The breadth of outlook which characterised the speech of Mr. Fisher and the readiness with which he is prepared to enlist the co-operation of industrial and other interests in the development of schemes for continuation classes justify the hope that in the actual application of the schemes and their subsequent development the maximum of utility may be achieved. To the engineer it will be of interest to note that Mr. Fisher's proposal to establish compulsory part-time day continuation schools for those who have left school before the age of 16 coincides with the views held by many heads of industrial concerns and so ably put forward by Sir Trevor Dawson in his paper read before the Association of Technical Institutions in October last.* This coincidence of viewpoint between the broad-minded practical engineer and the educational expert is further emphasised by the fact that each lays the greatest stress on the inclusion in the educational course of such physical and mental instruction as will best aid in the production of healthy and contented citizens and efficient workers.

Of the widespread interest which is being taken in the education of the future citizen and worker there is now ample evidence. In July a report on the adequacy of our educational system in providing for the commercial struggle which lies before us was presented to the Council of the Administrative County of London, and the report states that of the engineering employers whose opinions were asked practically all expressed themselves in favour of compulsory continuation classes, while the majority agreed that it was too much to expect apprentices to attend evening classes. In South Africa the Transvaal Chamber of Mines has been moving in the matter, and a sub-committee appointed by them to consider the training of apprentices in mines has issued an interesting report, of which the following are the main features: Apprentices are divided into two groups, viz., trade school and ordinary. Trade school apprentices take a course of two years at a trade school previous to starting their apprenticeship of four years at their trade. Ordinary apprentices start directly at their trade at a minimum age of 15 and serve five years. The trade school fees are paid by the employer in approved cases and the trade school apprentice is paid a wage which exceeds that of the ordinary apprentice by 2*s.* 6*d.* per day in the first year to 3*s.* 6*d.* per day in the fourth year. From these two examples it will be seen that a serious attempt is already being made to put into practice the principles of the continuation scheme of education for which Mr. Fisher is now working, and it is satisfactory to know that the engineering industry is fully alive to the necessities of the case.

Accepting Mr. Fisher's standards of education of (*a*) a youth who continues at school till he attains the age of 16 years, and (*b*) a youth who leaves school before the age of 16 is attained and who must as a consequence continue his education at the compulsory continuation school till he reaches the age of 18 as the minimum standard of education for the future, what, then, is the position of the engineering employer with regard to the education of his apprentices? It is obvious that any improvement in the theoretical and practical knowledge of their trade which can be acquired by a body of workers will react for good not only on these workers, but also through the natural dispersal of these trained workers to other shops upon the employers as a whole. It thus follows that all should contribute to the educational effort. The question of how best to concentrate and direct this effort might well be the subject of discussion at a meeting of representative employers from the leading centres of industry and broad-minded educationalists of the type of Mr. Fisher, but a few remarks as to alternative schemes may be of interest. The schemes which suggest themselves are: (*a*) evening continuation classes as at present carried out in most industrial centres; (*b*) attendance at a trade school for a period of, say, two years before starting to serve apprenticeship in shops, with subsequent evening technical classes; (*c*) attendance at classes during the daytime on certain days of the week while serving an apprenticeship in the shops during the remaining days. There are, of course, many possible modifications of the above, such as the "sandwich" system, for instance, but for the average boy it seems probable that the choice will be one of the above.

With regard to the alternative (*a*) it must be said at once that the general concensus of opinion is against the evening continuation class for boys under 16 years of age, and this opinion is borne out by those having charge of such classes. It may, therefore, be said that for boys under 16 the evening class should not be insisted upon, but for boys over 16 and attending technical classes the evening classes have proved very suitable—especially in the West of Scotland, where evening technical classes have recently done excellent work with engineering and shipbuilding apprentices.

For (*b*) there is much to be said—especially on behalf of small employers, as there is no dislocation of shops and machines involved owing to the absence of apprentices at school on certain days of each week. Attendance at a trade school from the age of 14 to 16 years would ensure that all apprentices started with a sound groundwork of knowledge upon which to build their shop and technical education, and would incidentally provide an opportunity for ascertaining the general suitability or otherwise of each boy for the class of work which he had chosen. Under careful guidance much might be done during this period to select the man for the job in a logical and scientific manner, and thus avoid much of the trouble which at present exists through boys and men entering a totally unsuitable occupation. The provision of these schools and the

* See ENGINEERING, vol. cii, page 414.

upkeep where they were situated in a busy manufacturing centre would be a fairly simple matter, and there does not seem any reason to doubt that the manufacturing firms would contribute readily to this object. The fact that a number of firms at present run classes inside the works for their own apprentices, and that this practice is extending, would seem to warrant the belief that the institution of a carefully considered educational scheme on the above lines would meet with a ready welcome.

It is probable that (*c*) is the most widely known proposal, and certainly there is much to commend the system of simultaneous theoretical and practical instruction which is involved, especially as this system could be employed in the case of lads of 14 years and upward. There is, however, the grave disadvantage of the interference with the working of the shops or yard involved in the removal of a number of apprentices. The natural solution to this is of course, a double shift of apprentices, but as there is at present a very great difficulty in obtaining apprentices in some trades and districts, and as the voice of the trade unions has not yet been heard on the matter, there is no certainty in a solution on these lines, and the dislocation of work remains a serious difficulty.

On the whole it would seem that the solution of the problem lies in the adoption of one of the above schemes or some combination of the schemes outlined, and the work of devising the most suitable scheme for each locality is one of pressing necessity and should command the best efforts of employers and educationalists. While the efforts of those firms who have already done such good work in establishing schools in their own works is worthy of the highest praise, it is obvious that the maximum benefit can only be derived when these individual schemes are co-ordinated and expanded so as to embrace all employers and their apprentices.

EXPENDITURE ON WAR MUNITIONS.

As it is not in the public interest to disclose during war time the full details of the public expenditure by means of estimates presented to Parliament, difficulties have arisen in connection with the checking of national expenditure in the House of Commons sitting in Committee. Consequently greater importance attaches to that close investigation which is made by the Committee of Public Accounts appointed by the House, and their report on the national expenditure during the financial year 1915–16, which is issued this week, although without the evidence and appendices, shows that careful attention has been given to the details, the great spending departments having prepared, as far as possible, complete accounts for the year, which it may be possible to publish when the war is over. The exigencies of war, and particularly the importance of avoiding delay when ordering supplies, has rendered it difficult for the Treasury to exercise the same control in such matters as in peace time. From the point of view of early and rapid delivery of war munitions this departure from peace conditions was inevitable and is commendable. But emergency departmental committees were set up in the case of the Admiralty and, at a later date, of the Ministry of Munitions, so that the Treasury was kept in close touch with the departments and was enabled to exercise as much control as was possible without unduly delaying the work. In the case of the War Office a similar arrangement was considered impracticable. In the year under review the total expenditure on the Navy, Army and Ministry of Munitions was met from the votes of credit passed by the House of Commons from time to time, and instead of the normal estimates token estimates only were presented. The Committee of Public Accounts are of opinion that, "whatever may have been the necessity for this procedure in the earlier stages of the war, the time has now arrived when estimates more approaching to those in force in normal times should be presented to Parliament, not merely for the fighting services, but also, where practicable, for the new services now charged direct to the Vote of Credit, *e.g.*, War Refugees, Central Control Board (Liquor Traffic), War Trade Department." This, however, cannot mean that in the case of the Navy information would be disclosed of a more or less precise nature regarding the number of ships of each class in progress, to be completed and to be laid down. There are cogent reasons why such disclosure would be inimical to the national interests.

In connection with the Navy accounts it is brought out that the net deficit charged against the Vote of Credit for 1915–16 amounts to 205,716,586*l.* 17*s.* 7*d.*, after taking into account appropriations-in-aid of 1,186,617*l.* realised in excess of the estimate. This, we presume, may be accepted as the Navy expenditure for the year under review, and appears to be only about four times that of the estimate prepared, in peace time, for the financial year 1914–15. No information, of course, is given as to what proportion of this increase is for new shipbuilding. The Committee refer to the continued difficulty of checking overtime payments at Rosyth, but the Admiralty are instituting trial checks, and believe that circumstances will soon allow of a more complete system of double check being established. In connection with the contract work the Public Accounts Committee deal with the problem of contracts on the basis of net cost, plus percentage for establishment charges and profit, to which we referred in our leading article on "Time and Line" in our issue of July 20 last (page 67 *ante*). It is brought out that the Admiralty Departmental Committee, the function of which, as already stated, is to bring about a closer relationship between the Admiralty and the Treasury, reported that the system of fixed percentages for establishment charges is "open to objection," and that in some cases the percentages actually fixed were "unreasonably favourable to the contractors." This Departmental Committee observes that "a system which allows a contractor a profit upon every increase in the cost of the work presses very injuriously on the Admiralty, and, in cases where it is possible to arrive at a probable estimate of the cost before the work is commenced, they suggest: (*a*) an arrangement by which the contractor's profit is limited as the cost of the work increases or increased as such cost diminishes; or (*b*) an arrangement by which a contractor's profit is fixed beforehand at a definite sum." The Treasury prefer the latter alternative, and the Admiralty is now adopting a form of contract which follows either one or the other suggestion or, in certain cases, combines them both. This, it will be seen, meets the objections which we pointed out, and which, as indicated in our article, have an injurious effect on the continued efficiency of well-equipped establishments by reason of the fixed percentage of establishment charges. Thus they are placed on an inequality with works where labour-saving appliances are not adopted to the same extent, and where, therefore, labour involves a greater expenditure on such contracts. We have heard of cases where, owing to the high cost of labour. ships cost the Admiralty from 30 per cent. to 40 per cent. more than vessels of exactly the same design built in well-equipped, well-organised yards. In connection with the payment of contractors for the acceleration of certain ships ordered under fixed-price contracts made prior to the war, a special committee has been appointed, and includes a non-official Member of Parliament, of great experience in this class of negotiation in private trade; the settlement of these claims is proceeding satisfactorily.

As regards the Army accounts, the interest of our readers naturally centres in the expenditure of the Ministry of Munitions. This department was instituted by Order in Council dated June 16, 1915, and the extent and rapidity of its expansion is disclosed by the fact that the headquarters staff, which at first numbered less than 200, had grown to over 10,000 by March 31, 1917, in addition to a very numerous inspecting staff. Of this number about 330 are in the service of other Government departments, whose salaries, amounting roughly to 100,000*l.* per annum, are paid by those departments, and, in addition, there are 405 officers and others whose pay and allowances, amounting to 139,350*l.*, are charged against Army votes. There are a further number of 254 who give whole-time services without any salary, and 150 of these are high administrative officers. The salaries paid by the Ministry to men in somewhat equivalent positions range from 3,000*l.* to 400*l.* per annum. Of the other officials some 40 or 50 receive only more or less nominal sums towards the special expenditure incurred by their serving in the Ministry and by living away from home. The Committee point out that "this voluntary service is not to be measured merely by those who draw no salary, but by the larger number who take a very small figure, salaries and allowances being in many cases below ordinary commercial salaries. Besides this there are a large number serving on committees giving part time in an advisory capacity. In addition to the staff of the Ministry itself there are 46 local committees and management boards throughout the country, comprising in all at least 250 men whose work is entirely honorary, though a few of the secretaries had to be paid." We are glad that this official recognition has been paid to the extensive and valuable service patriotically given by men, many of them engineers of great administrative ability and technical experience. The Committee, however, state that they are not satisfied that Treasury control should have been relaxed over the employment of civilian employees which are on a temporary and non-pensionable footing, at salaries not exceeding 400*l.* per annum. More might have been said on the inefficiency of some of these officials for the work they are required to do, and also on the feasibility of reducing the work of supervision of manufactures, which might well be left in the hands of experienced firms.

The only indication of the money disbursed by the Ministry of Munitions for war supplies is that the total sum charged against the Vote of Credit for the year 1915–16 was 222,703,883*l.* 15*s.* 7*d.* This of course includes the expenditure on national factories for the production of projectiles, for shell-filling, explosives, propellants and trench warfare department factories. In the case of projectile and filling factories there was no production prior to March 31, 1916, but the number of these factories increased between April 1, 1916, and March 31, 1917, from 63 to 149, exclusive of the existing factories at Woolwich, Waltham, Enfield and Farnborough. Of the new factories, that at Gretna is the largest. The official estimate placed before the Treasury put the cost at about 2,000,000*l.* This has been increased from time to time, "uncontrolled by the Treasury." The estimated expenditure up to March 31, 1917, is 8,000,000*l.*, and the Committee are "informed that developments of the scheme have been sanctioned which will involve further expenditure, the amount of which cannot at present be determined." The Committee are further "informed that calculations have been made as to how far this expenditure is justified from a money point of view, and it seems fair to state that, in the opinion of the Ministry of Munitions, at the cost of production which has now been reached, and assuming the factory continues in full production, in about a year's time it should pay for the whole expense, compared with the prices which were being charged by the American producers." The English is not ours; but our readers will no doubt understand what is meant. It is stated further that "the erection of this and other explosive factories has not only effected a reduction in the prices of materials purchased from abroad, but has prevented these prices from soaring still higher."

In connection with these factories the Committee return to the subject of payment on the net cost plus percentage basis. The Committee made particular inquiries as to the supervision of the Ministry, both as regards the numbers of men employed, the rate of wages and the scale of overhead charges, and while "in the earlier stages the results are open to criticism," it is stated that "as far as possible careful and effective watch is now kept on all these points." The Committee were informed that, "in view of the increases of pay granted from time to time to meet the exceptional conditions, a proposal is under consideration that such increases of pay should not carry any percentage, and the Committee are of opinion that some such arrangement should be effected." The Committee recommend that "where it is necessary to employ contractors who are remunerated on the basis of net cost and percentage, such remuneration should be paid on a sliding scale." The Committee

point out that "the revision of prices by means of costings has had a considerable effect in bringing home to manufacturers the importance of minute investigation into their records, to ascertain the true cost of production." This is a development which is to be highly commended. Exception, however, must be taken to the claim which seems to be made that the economies effected are due to this cause alone. It is pointed out, for instance, that the costs have been reduced by several millions, in some cases by as much as 40 per cent. or 50 per cent. In the case of shells and cordite alone the reduction on a full year's output was 1,734,000*l.*, when the 1916 prices were compared with those of 1915. The total saving in 1917 is estimated at 43,000,000*l.*, notwithstanding the rise in wages. A large part of this saving must be attributed to the construction of new factories specially equipped for the manufacture of shells or other war productions, in place of using workshops and machines designed and laid out for entirely different productive work and utilised in great haste for munition-making, as well as to the training and organisation of staff and men for specialised war work, with a resultant accumulation of experience. The only other point to which we would direct attention is the proof of the want of co-ordination between different branches in the early days of the Ministry, more especially in the matter of placing contracts, which led to waste of public money without any advantage to the contractors. Considerable improvement was effected by the later arrangements, under which the accounting officer was given financial control in the case of all important contracts in excess of a certain sum.

INDUSTRIAL COUNCILS AND THE GARTON MEMORANDUM.—No. II.

The summary begun in the previous article of the argument of the Garton Memorandum is here continued.

(*g*) *The Status Desired by Labour.*—The great obstacle to the co-operation of employers and employed is, in fact, not economic at all. It lies in the unsatisfactory *status* of the workman.

Collective action by the workmen of a powerful firm is impossible without the help of their trade union; and the strike, which in the last resort is the union's only effective weapon, inflicts acute personal suffering on the men and their families, as against mere pecuniary loss to their employers. Workmen feel that in this and other ways they are unfairly handicapped. They resent still more the fact that they are only cogs in the industrial machine. A workman has no say in the management of the business, nor any control over the admission of youths and men to his trade and the demarcation of tasks, or over new methods of working, labour-saving machinery, dilution of labour, or scientific management, all of which he believes to be framed solely in the interest of employers. His wages seem to him either a dole fixed arbitrarily by the employer, or a concession extorted by force; and even for increased wages men will not accept "methods of work which involve loss of self-respect or a narrowing of their life by undue restriction of leisure."

The employer, on the other hand, is actuated as a rule neither by tyranny nor by avarice, but by impatience of the men's failure to understand the interests that they have in common with him. He feels their demands to be mere raids on his profits, limited only by the chance of success and the power of the unions, and unaffected by any regard for the responsibilities, such as working expenses, depreciation, and reserve, for the discharge of which he has in the common interest to provide.

The disputes over wages, indeed, are fought less because of the money rights and needs of the men than because wages have come to be the symbol of the dispute as to *status*. Labour, because it knows itself to be indispensable to the production of wealth, requires to be treated "as a partner, with equal rights and equal responsibilities." The employer, on the other hand, complains of deliberate limitation of output, slackness and inefficiency, short time and malingering; of the dogmatic repression by Labour leaders of loyalty to the firm from whose operation come the earnings of Labour no less than those of Capital; of trade-union regulations impeding the preferential reward of efficient and industrious men and the continued employment of those whose productivity has been reduced by age or accident; of bargains made with unions and broken by the men, whom the unions have forbidden to deal direct with him.

(*h*) *The True Principles of Reconstruction.*—This situation, if it continues after the war, will restrict production; the consequent suppression of earnings will restrict saving; discontent and hopelessness will increase extravagance, and reduce even the will to save; the instability of industrial peace will discourage sound investment. It is, in fact, a state of mutual hostility between employers and employed, and the prime obstacle to the increased output, saving and confidence that are essential to industrial prosperity.

The true solution of the industrial problem must, therefore, be based on four broad principles. The first necessity of the situation is greater efficiency of production, both in volume and quality of output. This efficiency must be sought in improved organisation and reduced waste and friction rather than in increased strain on workers, and must include a worthier and more clearly recognised place for industry in our national life. To this end the sectional treatment of industrial questions must be replaced by the active co-operation of Labour, Management and Capital. To secure this co-operation Labour must be given "a voice in matters directly concerning its special interests, such as rates of pay and conditions of employment"; and for united action and the adjustment of competing interests machinery must be created powerful enough to enable both sides to accept its decisions with confidence that any agreement arrived at will be generally observed.

To many who wish for the abolition of private ownership of capital and of land, with the necessary economic consequences of that step, these measures will seem quite insufficient, and the co-operation of Labour and Capital directly mischievous. But the State cannot move in advance of public opinion; and whatever may be the right direction of industrial progress, an advance towards it is less likely to be founded on the chaos of industrial warfare and class hatred than on a definite first right step. The measures necessary for a revolutionary change in the constitution of industrial society could, moreover, not be introduced in time to prevent the imminent industrial crisis. And if even there were time, a social or political upheaval would historically be unlikely to result in a specific programme or to end as had been intended. The men whose ideas gave birth to the French Revolution did not foresee either the Terror or the Empire.

The gain, in fact, to any class through conflict is shadowy and uncertain; the loss and suffering to all classes is certain and heavy. The changes that the war has produced in men's minds and the nation's circumstances will not be unmade by ignoring them; while by harnessing to our own uses the forces that catastrophe has released we may not only avoid chaos but contribute largely to the future welfare of the nation. To do this may involve legislative sanction or State action; but mere State control would leave untouched most of the difficulties here analysed, and a settlement can only be made by agreement between those chiefly concerned.

(*i*) *The Bases of Agreement.*—As a step towards such agreement the respective functions and qualifications of Capital, Management and Labour should be defined.

Capital has to provide means for erecting plant, buying raw material, and paying working expenses, and to bear the attendant risk and delay. Its owners require sound judgment, dictating caution or daring as occasion requires.

Management has to use the capital, to erect and work machinery and plant, organise the business, place and accept contracts, buy and sell. It must have a knowledge of the business and of all others in any way connected with it, and must make a careful study of markets, methods of distribution, and financial conditions. Labour has to convert raw material into finished product by aid of the plant and machinery provided. For maximum efficiency a man must not only understand his own job, but also have a clear conception of the part that his work plays in the whole process of production.

With suitable, but not vital, changes these definitions can be applied to distributive industry as well as to the manufacturing business for which they were framed.

The functions so defined obviously overlap. Capital is the result of past services performed by all three parties. The capitalist may also be the manager; the workman, if a foreman or ganger, combines to some extent the functions of labour and management. No clear line of demarcation can be drawn; and this interrelation of functions constitutes a real partnership* between "all the persons concerned in any business," though one in which hitherto a fundamental principle has been neglected." The first article of partnership must be equality of knowledge. But workers know little of capital risks, working expenses, establishment and depreciation charges, or the relation of their job to the general process of production. Employers, on the other hand, understand very imperfectly the workers' point of view, their susceptibility to social as well as economic considerations, and the effect of the work on their physical and moral life. Neither side, in fact, understands the standpoint of the other; and misunderstanding and disputes can thus be settled only by arbitrary solutions, when with mutual understanding and sympathy they might be avoided or compromised.

What the workmen desire is a sense of self-respect and responsibility, "a greater and greater degree of self-direction by the organised workers themselves, acting through their accredited representatives"; and the problem is to give it them without interfering unduly with the necessary functions of management. The trade-union attack on employers' profits and their right to control their own business has been due to the assumed conflict between the fundamental interests of employers and employed; and the great employers' associations have arisen largely as a defence against the unions. On the whole the effect of these organisations has been beneficial to both sides; but although they have done useful work in restraining both tyranny and anarchy, in compromising disputes and restricting the occasions of them, their action has been almost entirely defensive. They have done little or nothing to remove the latent hostility and divergence of effort that have hampered industrial development more even than strikes and lock-outs; they have taken no combined action in the interests common to both sides, and their results have hardly been commensurate with the energy absorbed. These two groups must now undertake continuous and constructive co-operation, each recognising and respecting the separate interests of the other side, the common interests of both sides, and the overriding interest of the nation; and joint action to regulate every phase of industrial development, if it was taken with the combined strength of these powerful and highly organised bodies, would be practically irresistible.

(*j*) *The Proposed Machinery.*—Such co-operation will require special machinery. Conciliation Boards may be retained to settle specific disputes; but, invoked as they are only after differences have arisen, they have no influence in preventing dispute, and they are not a means of the continuous and constructive co-operation that is necessary. The foregoing analysis of the difficulties to be overcome may indicate the lines on which development is possible.

In its simplest form the new machinery would consist of Joint Committees, representing the management and the works staff. To such committees the management "would be required to explain the nature and extent of any proposed innovation designed to increase output or economise effort—the introduction of new automatic machinery, time and motion study, standardisation of tools, analysis of fatigue, elimination of waste—and its effect upon the earnings of the firm and of the individual worker. The explanation should be as clear and full as possible, with the object of giving

* The term is used in its widest sense, without involving the acceptance of what are generally known as co-partnership schemes.

each worker an interest and sense of responsibility in his work, by making clear to him, through his representatives, the *reason* for the methods to be adopted and the relation of his job to the whole process of production." The workers' representatives would consider "the relation between different classes of labour, the strain on the workers, the amount of interest and intelligence put into their work" [*sc.*, by the innovations proposed], and any other interests of the men, and would put forward any necessary modifications or safeguards. Real divergence of opinion or of interest would have to be settled by free discussion. Proposals would similarly be put forward by the workers' representatives for alterations of the hours and conditions of work in the interest of the health or social welfare of the workers, and the representatives of management would urge any objections of expense or difficulties of working. Each side, though concerned mainly with its own interests, should not confine its attention to them. The employer should have the interests of his staff at heart, and workmen should have many suggestions for promoting the efficiency of the business.

For staple trades this arrangement would be replaced or supplemented by Joint Boards, representing employers' associations and trade unions respectively; possibly constituted as two co-equal boards with a Supreme Board of Control. The Management Board would deal with the "business" side of the industry; the Labour Board with conditions and hours of labour, demarcation of tasks, and the like. The Supreme Board of Control, composed of representatives of these boards, would deal with questions affecting both sides; such, for instance, as dilution of labour, considered both from the point of view of efficiency and from that of the interests of the workers and the position of the trade unions. District and Works Committees, represented on the Central Boards, might deal with local and individual interests and problems, such as the effect on rates of pay of wide differences in the cost of housing and food or of working expenses. "They would also serve as a protection to established workshop and local craft traditions against the deadening tendency to a mechanical uniformity."

In its most ambitious form the Supreme Board of Control would become a National Industrial Council for each staple industry or group of allied industries. Members would be chosen by ballot, each unit returning one management and one labour representative, a Speaker being chosen by mutual consent. These councils would in no sense supersede the existing employers' associations and trade unions. Commercial matters, such as the sources of raw material and markets for finished products, would remain the exclusive concern of the associations, acting in conjunction with the State. The benefit side of the trade unions and many phases of the internal organisation of labour by them would be similarly unaffected. Both unions and associations would be represented on the Industrial Councils, and would be entrusted largely with the detailed execution of the Industrial Parliament's policy.

The scope of the councils would include, among other matters, methods of organisation, discipline and output, design and workmanship, apprentices and conditions of entry into the industry, demarcation of tasks, unemployment and security of tenure, wages and piece rates, research and experiment, and the public status of the industry. If a council represented a group of industries, it would co-ordinate their activities and adjust their respective interests. The councils would "give public utterance to the views and needs of each industry in relation to the whole national life." Their purpose would be not merely to increase productive efficiency and reconcile interests, "but to emphasise the worth and dignity of industrial life and to enlarge the scope offered by it to the energies and ambitions of those concerned. It would be their task to emphasise the close connection between industrial questions and those relating to education and social conditions. It might even be advisable to empower the Industrial Councils to apply for Board of Trade Orders giving legal sanction to their decisions."

The danger of tyranny seems almost inseparable from a close corporation, but in view of the enormous advantages of the councils this danger must be faced without flinching, relying on the help of the legislature and the courts.

Such a scheme, when once properly started, would tend to give the employers' associations greater power to control the action of individual firms, and to enable trade unions to make agreements with greater certainty that they would be carried out. The organisations should evidently proceed *pari passu* on both sides, so as to retain approximate equality of strength. At the outset the scheme should avoid hard and fast lines, leaving itself elastic enough to be adapted to practical needs and requirements as time and experience reveal them. The system might even be applied in unorganised trades. In the engagement of men, for instance, "it should be possible to take advantage of the special knowledge of both sides by consultation between the managers and the representatives of the works staff as to the numbers and qualities of the men required. In some cases it might even be possible to appoint a permanent Joint Committee to deal with the question of the supply of labour and the requirements of the work in hand."

(*k*) *Concrete Examples.*—Without identifying themselves with its suggestions, the authors quote in an appendix, "as a concrete example of one way in which the principles of the Memorandum could be experimentally applied, a scheme for the working of the Post Office prepared by the general secretary of the Postal and Telegraph Clerks' Association. Trade unionism is stated to be powerful and well organised in the Post Office service, and the unions are recognised by the authorities. They have the right to make representations on "general questions relating to the conditions at work, *i.e.*, wages, hours of duty, leave, meal reliefs, &c"; not on questions of promotion, and on questions of discipline only when the individuals concerned have exhausted their own rights of appeal unsuccessfully and the association can submit new facts or considerations. Such representations at present are made by a central association, and the essential change proposed is to set up local Advisory Committees, consisting of representatives of each grade of employees, of the management staff, and of the central association, to deal with local matters, including questions of discipline and promotion. "It is not suggested that the new committees shall have a deciding voice. Where no agreement can be reached in them the decision must continue to rest, as now, with the supervisory authorities"; but the system would extend the principle of responsibility, and would produce suggestions bred of inside knowledge, constructive rather than critical in tone. If it were found possible to earmark the profits of the Post Office "for some special purposes of social usefulness, in the choice of which the associations might have a voice," the feeling of "exploitation would be removed, and a strong incentive given to individual effort to improve the service.

In a second appendix the authors describe a scheme that has been adopted successfully in a large manufacturing business "for creating a better understanding between the principals and the employees, and for promoting the efficiency of the business." It consisted of a course of 12 lectures to the management and staff by an outside person who had given much thought to industrial and commercial questions, and had received every opportunity of learning all the details of the organisation, methods and finances of the firm, and the working conditions and views of the workers. These lectures produced so good an effect that a further series of 12 weekly afternoon lectures were given to several hundred selected representatives of the workpeople, who were paid their wages for the time of attendance. The lectures dealt with "the nature of the business, the principles of industrial efficiency, and the true nature of industrial relations"; and the lecturer, who was left quite free as to what he should say, gave praise or blame impartially on the results of his investigations. "The improvement in the relations between the firm and its employees surpassed all expectations"; and the scheme, which is in future to form a permanent part of the organisation of this business, is commended to other employers who wish to establish a new spirit in their works.

FERRO-CONCRETE VESSELS.

The recent experiments in the construction of ferro-concrete vessels have aroused an unusual degree of interest, and shipyards for the construction of such vessels have been, or are about to be, started in several places. Reinforced concrete vessels are by no means new. During the last six or seven years several have been constructed experimentally, but little or no progress on a commercial scale has so far been made. It is probably only the shortage of tonnage resulting from the war and the difficulty of obtaining the ordinary raw materials for shipbuilding, which have caused engineers to take up the question in earnest.

It may be of some interest to mention a few isolated examples of ferro-concrete vessels, built within the last five or six years. In the autumn of 1911 one of the Danish Boards of Engineers commenced the building of a barge or lighter of the following dimensions: length, 47 ft. 6 in.; breadth, 13 ft. 10 in.; and depth, 5 ft. 10 in.; carrying capacity, about 27 tons d.w. It was built of ferro-concrete, both the design and the construction being in experienced hands. It was taken into use in the following spring. In the design much attention was paid to the protection of the bows and sides against impact, heavy fenders of wood being attached to all the exposed places by means of bolts cast into the reinforced concrete. The inside of the vessel was also effectively protected by wood. This lighter has proved quite satisfactory, and no drawbacks have been found to attach to the material used. Some time previously the Danish Royal Dockyard had ordered some ferro-concrete pontoons for a floating bridge. They served satisfactorily for some time, until one night, during a heavy gale from the north, which caused considerable sea in the outer harbour, a good-sized hole was chafed in one pontoon by a piece of floating timber between it and the pierhead, with the result that the pontoon was filled with water and sank, carrying down the other pontoons and the entire bridge. At about the same time the dockyard built some ferro-concrete pontoons for a pile-driver float. These have proved satisfactory. They are protected against chafing by wooden fenders on the sides and other exposed parts. The report from which the above details have been obtained states that experience has shown that ferro-concrete, rightly designed and constructed by men skilled in this special branch, may prove a reliable material for floating constructions, including vessels, provided that they are effectively protected against impact and chafing, &c.

In Germany and Holland several small craft have been built of ferro-concrete during the last few years, and quite recently lively interest has been taken in the matter. In Hamburg a ferro-concrete lighter was taken into use in the coal harbour some three or four years ago; the bottom, the sides, the frame, and all the ribs were of reinforced concrete. It comprised some small watertight compartments, but the cargo space was entirely unobstructed. The more exposed portions were also in this case protected by broad wooden fenders built into the concrete.

A Stettin firm built a motor boat of ferro-concrete some five years ago. The vessel was divided into four compartments by bulkheads, which also served to stiffen it. The motor rests on wooden beams, which are attached to a concrete foundation. It is of the two-stroke type, and of 5 h.p. This vessel has been used as a pleasure boat, and apparently has given satisfaction. Also in Holland ferro-concrete boats of modest dimensions have proved efficient. The first ferro-concrete motor boat on the Boden lake was put in the water at Constanz some five years ago. In Russia the use of ferro-concrete vessels for coasting and river traffic has also commenced, a French vessel built at St. Rafaele being accepted as a model. Russia is rich both in cement and sand, in addition to which ferro-concrete vessels are fireproof, which is considered a great advantage in a country where fires on board the river craft are stated to be frequent. For the transport of naphtha products, boats built of this material are considered particularly well adapted.

The instances referred to above are all small boats, which, though apparently satisfactory enough,

did not lead to anything approaching a regular industry. This, however, has now been instituted. We have already several times referred to the subject in connection with the Norwegian yard exploiting the Fougner patents. In Sweden one cement-working concern has constructed some barges, used for transport in their own business, and another similar firm is also about to make a start in the same direction. In Denmark, too, the matter has now been taken up.

The Fougner company at Moss has recently obtained the necessary permission from the Norwegian authorities to commence the construction of two ferro-concrete vessels, without waiting for the final report from the Concrete Ships Committee. The two vessels are of respectively 600 and 1,000 tons, and the fact that the Government has given this dispensation shows that a considerable interest must be taken in this new material for shipbuilding. The vessels in question will have four watertight bulkheads, double bottoms of ferro-concrete, and water-ballast tanks fore and aft. In deference to the requirements of the authorities these new vessels are built about 20 per cent. stronger than the yard would normally make them, which, however, does not mean an increase of 20 per cent. in the weight of the vessel. The dimensions for the 1,000 tons boat, of which we reproduce an elevation, are: length, 166 ft.; breadth, 31 ft.; depth, 18 ft. The authorities have stipulated for a particularly ample equipment with regard to life-saving appliances, and the first ferro-concrete vessels will have to undergo special tests before the delivery can take place. The boats resemble the so-called canal-barge type, which is well known both in Norway and Sweden. The propelling power is supplied by two Bolinder crude oil motors of 200 h.p. each. The first two Norwegian concrete vessels are expected to be ready in the course of October. Another Norwegian yard is taking up the construction of good-sized ferro-concrete vessels, and intends to make a speciality of standard types.

In one respect Denmark seems to have taken the lead in connection with ferro-concrete shipbuilding, inasmuch as official rules have been laid down for designing such vessels; neither Norway nor Sweden has, so far, found it convenient to issue such regulations. The Danish rules have been worked out by the well-known expert in ferro-concrete matters, Professor E. Suenson, of the Polytechnical High School, Copenhagen, who is a member of the committee on ferro-concrete vessels. The rules apply to the building of small flat-bottomed vessels of ferro-concrete.

Basis for Caiculations.—The dimensions are to be fixed on the basis of the Union of Danish Engineers' rules for structural work in ferro-concrete, subject to the following regulations.

The bottom and sides must be at least 7 cm. (2.8 in.) thick. Flat surfaces less than 8 cm. (3.2 in.) thick are to be considered as simply supported unless so reinforced as to be capable of withstanding bending moments in both directions.

The tensile stress on the metal must not exceed 8 tons per square inch; the compressive stress on the concrete must correspond to a factor of safety of 7, or a maximum of 800 lb. per square inch. When the calculated shear stress on the concrete exceeds one-tenth of the compressive stress provision must be made for taking it wholly on the metal reinforcement.

In calculating the strength of the hull the vessel is assumed to be riding on a trochoidal wave of length L, equal to the length of the vessel between perpendiculars and with a height equal to one-twentieth of the length. The cargo compartment is taken to be fully laden with a homogeneous cargo. The calculation is to be made both for the condition when the vessel rides on a wave crest and for that in which it lies in the trough.

The transverse strength is provided for on the hypothesis that the vessel is fully laden, but in such a manner that the cargo is evenly distributed over one-half the total area of the hold while the other half is free. The maximum external pressure to be provided for is that due to the draught $\pm \frac{L}{40}$, where L is the length between perpendiculars. No allowance is made for any distributing effect of the longitudinal girders. The bottom of the hull is taken as a beam subject to a uniformly distributed load q and to the bending moments due to horizontal thrusts H applied at the point at which the sides and deck girders intersect (see Fig. 2). The direct action of the water pressure on the sides is ignored, but is provided for in fixing the value of H, for which the following formula is adopted:—

$$H = \frac{q}{4}\frac{b}{h}\left\{\frac{b}{3+2\frac{I_2}{I_1}\frac{S}{b}}+2a\right\}$$

Here q denotes the uniform load per square foot on the bottom of the hull, whilst I_2 and I_1 represent the moments of inertia of the cross-sections of the bottom and sides respectively.

The stresses are calculated for the two values of q, viz.:—

q = maximum water pressure − w
and q = minimum water pressure − w

where w denotes the weight per unit area of the floor plate.

The side ribs are investigated for the same two cases of loading as the bottom plate, and also for the cases represented in Figs. 3 and 4.

The deck is dimensioned for a load of not less than 700 kg. per square metre plus its own weight.

The through deck girders are assumed to form in conjunction with the side ribs a two-hinged frame, the hinges being at the points where the centre lines of the side ribs intersect the centre line of the bottom (Fig. 3). The following value is assumed for H:—

$$H = \frac{p}{4}\frac{l}{h}\left\{\frac{l}{3+2\frac{I_2}{I_1}\frac{S}{l}}+2a\right\}$$

where I_2 denotes the moment of inertia of the deck beam.

The stringer plate c—c (Fig. 4), as a horizontal girder, must be able to transmit the horizontal pressure H (Fig. 1) to the through-deck girders at the end of the hatch. These deck girders are dimensioned for the horizontal pressure represented in that figure and also for the value of H corresponding to Fig. 2.

Watertight partitions are required to withstand water pressure from either side full up to deck level. Safety against local damage by collision is to be provided by giving the vessel such a shape that under normal conditions it can only be hit above the water-line. After completion the hull is to be painted up to the load-line with asphalt, coal tar or similar waterproofing coating.

Fig. 1.

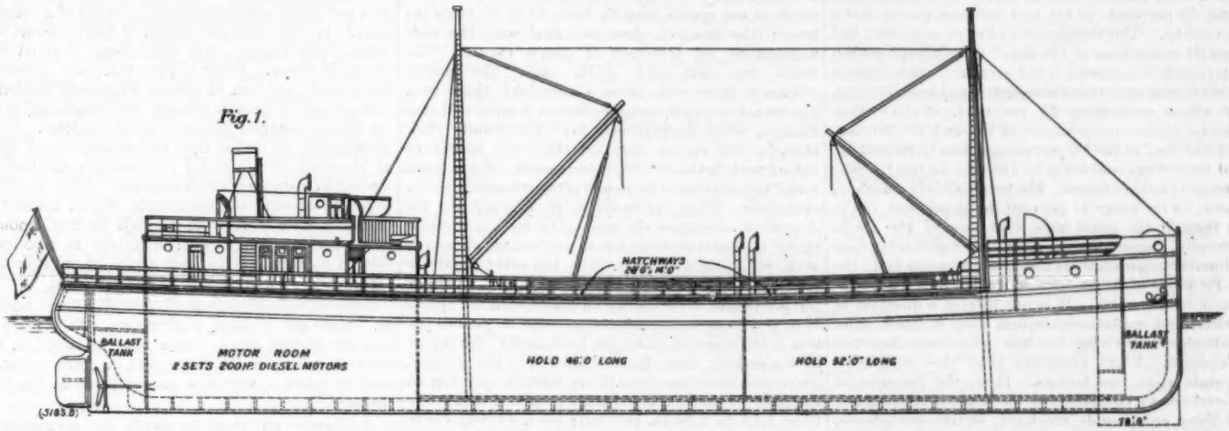


Fig. 2.

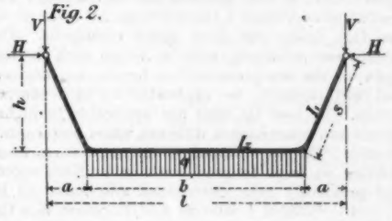


Fig. 3.

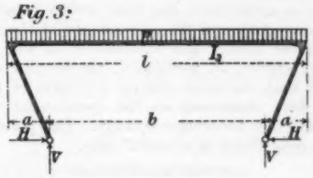
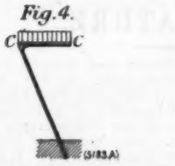


Fig. 4.



NOTES.

CERIUM-IRON ALLOYS.

THE recent research by R. Vogel on alloys of cerium and iron and their equilibrium diagram throws some light upon the nature of the pyrophoric properties of these alloys. Those properties are not understood, as we pointed out in a recent paragraph on pyrophoric alloys (ENGINEERING, May 4, 1917, page 424), and as the cerium metal obtainable is not pure, it remains possible that some impurity plays an important, but overlooked, part in the phenomenon, though we are not aware that this suggestion has received particular attention. Vogel experimented with a cerium of 95.6 per cent. which contained lanthanum and traces of iron, but seemed to be free from neodymium and praseodymium. He also had some ferro-cerium at his disposal, which the Elektrochemische Werke at Bitterfeld supply in small bars containing from 15 per cent. to 75 per cent. of iron. He prepared his high-grade alloys by melting cerium and adding Krupp iron, or by dipping a piece of cerium attached to a thin iron wire into the fused iron. Even when working with all precautions and speed in an atmosphere of nitrogen,

this latter operation was not always successful; the fusion was carried out in a tube of Haldenwanger porcelain, and when the cerium came in contact with the hot porcelain it caught fire, forming a nitride or an oxide, and the resulting slag destroyed the furnace tube. When one of the two metals is dissolving in the other, the temperature rises. The melting-point of cerium is 623 deg. C. according to Muthmann and 715 deg. according to Hanaman; Vogel (*Zeitschrift für Anorganische Chemie*, 99, pages 25 to 49, March 15, 1917) does not say more than that his cooling metal began to crystallise at 775 deg. Cerium and iron, he finds, are miscible in all proportions, and they form two compounds, first $CeFe_2$, which is changed into Ce_2Fe_3 at 773; the latter decomposes at 1085 deg. into a liquid and a solid solution rich in iron; the solution contains 15 per cent. of Ce, and becomes poorer in Ce on cooling. The compound $CeFe_2$ is magnetic, but loses its magnetism at 116 deg. Whether the second compound is magnetic is not certain. But there is another magnetic transformation-point near 795 deg. for alloys containing 25 per cent. of Ce; that transformation temperature is lowered to 750 deg. and 675 deg. as the Ce percentage rises to 60 and 65, and then drops suddenly to 116 deg. as the Ce percentage is further raised. The point is fairly constant, hence, for the range 15 per cent. to 55 per cent. of Ce. As regards the pyrophoric character of the alloys generally, some alloys must be vigorously filed before they spark, others need only be scratched; the Ce-Fe alloys of 70 per cent. of Ce are the most pyrophoric of the series. It is not merely a question of friction and oxidation; cerium itself is much more oxidisable than CeMg, but less pyrophoric than this compound. Vogel considers that the peculiarity depends upon two factors. First, the presence of at least one Ce compound in the shape of crystallites. All these compounds are hard, brittle, pyrophoric, and do not oxidise at ordinary temperature; that holds for alloys of cerium with tin, aluminium, silicon, bismuth, antimony, copper, lead, &c., all known in definite compounds. Secondly, there must be present a softer material, more readily oxidised than the compound. That material is cerium itself in the case of MgCe, which when pure is little pyrophoric, but improves in that respect when it contains free cerium. The same applies to ferro-cerium. Iron with 50 per cent. or 60 per cent. of cerium does not make a good igniter; but when it further contains free cerium it gives powerful sparks. When the first-mentioned crystallites are firmly interwoven, the rubbing or filing of the surface does not expose fresh oxidisable material; but when the crystallites enclose the softer cerium, friction will expose the latter, which is much more oxidisable, and the particles from the brittle crystallites catch fire.

Tractive Resistance on Electric Line Curves.

The tractive resistance of cars running on a curved track is greater than the resistance on a straight track of the same grade and construction. A knowledge of the additional resistance is needed for electric railways as well as for steam railroad construction. Nearly all the available information, however, has been derived from experiments on steam railways, and it is doubtful whether the values of curve resistance are directly valid for the single, self-propelled cars used on electric lines. The Railway Engineering Department of the University of Illinois investigated this problem, and the results of the investigation are published by Professor Edward Schmidt and Mr. Harold H. Dunn, of this department, in Bulletin No. 92 (51 pages) of the Engineering Experiment Station of the University at Urbana. By curve resistance they understand the tractive force needed by the car on curves in excess of the force required to move it over straight track, this force being expressed in pounds per ton of car weight. The car used had a length of 45 ft. and rested on two four-wheeled trucks, 23½ ft. from centre to centre, each truck having a wheel base of 6½ ft.; the equipped car weighed, together with its four 50 h.p.-motors, 28 tons. The resistance was determined when running the car on each of seven curves and when running it on the adjacent tangent track. The car was run first in one direction and then in the other, the speed being maintained as constant as possible in each pair of runs. The weather was mostly fair and the track dry, but the wind varied and blew up to 18 miles per hour; as the wind would more or less oppose the car movement in the one run of a pair and favour it in the other, the wind effect could be eliminated from the results obtained in different pairs of runs at different speeds. The seven curves used for the tests on well-laid tracks varied in curvature from 2 deg. up to 14 deg. 30 minutes. In our way of describing curvature we should say that the seven radii of curvature were 2,865 ft., 2,022½ ft., 1,563 ft., 1,146 ft., 882 ft., 717 ft. and 396 ft. The lengths of the track sections were 500 ft., 1,737 ft., 1,125 ft., 714 ft., 365 ft., 176 ft. and 276 ft., and the maximum superelevation of the outer rail varied from 1.2 in. up to 6.9 in. The curves were not very sharp, it will be seen, but the tests were made at car speeds ranging from 10 to 40 miles per hour; the research does not deal with the slow negotiation by tramcars of sharp curves. The track was laid with 70-lb. rails. The results obtained were not more concordant than such figures are as a rule, owing to flange, journal and gear friction, wind fluctuations, &c. The results show that for the car in question the curve resistance varied with both curvature and speed. For a given speed the resistance increases proportionately to the curvature; when expressed in pounds per ton per degree of curvature the resistance for a particular speed is thus constant for all curves, which agrees with steam-railway tests. On the other hand the value of the curve resistance expressed in pounds ton per degree of curvature increases with the speed. If R_c is the curve resistance, expressed in pounds per ton, S the speed in miles per hour, and C the degree of curvature, then $R_c = 0.058\ S\ C$. On a 1-deg. curve the resistance rose from 0.58 lb. per ton at 10 miles to 2.32 lb. at 40 miles; on a 2-deg. curve from 1.16 to 4.69 lb. per ton; on a 14-deg. curve from 8.12 to 32.5 lb. per ton, and on a 5 deg.-curve (radius of curvature 1,146 ft.) from 2.9 to 11.60 lb. per ton, under the same speed conditions. The results were relatively more in accord with the formula for the sharp curve than for the low degrees, and will probably be applicable for still sharper curves. In how far they are applicable to higher speeds and other cars of different wheel base cannot be said. The resistance of the car in question, when running on level tangent track at uniform speed, had previously been determined and found to be $R_r = 4 + 0.222\ S + 0.00181\ A\ S^2/W$, where W is the car weight in tons and A the cross-sectional area of the car in square feet; the other letters retain their meaning. Although the concordance of the results was on the whole more satisfactory for sharp than for easy curves, as mentioned, the peculiarity was noticed that the resistance on the curve of 396 ft. radius first decreased as the speed went up to 12½ miles, then to increase steadily. This peculiarity always reappeared in repeated tests.

LITERATURE.

Design of Steel Bridges. Theory and Practice for the Use of Civil Engineers and Students. By F. C. Kunz, C.E., Mem. Am. Soc. of Civil Engineers, Mem. Can. Soc. of Civil Engineers. Chief Engineer of the Bridge and Construction Department of the Pennsylvania Steel Company. First Edition. New York and London, 1915: McGraw-Hill Book Company, Inc. 472 pp., 52 folding plates. [Price 21*s.* net.]

On turning over the pages of this book the first impression is distinctly favourable. A more prolonged study serves but to confirm this view. Planned with judgment, the subject is treated with a regard to orderly sequence of the matters studied which is not found always in such works. It is not a "first book," the reader being supposed already familiar to a considerable degree with the study of bridgework. The author in his preface liberally concedes that many excellent books have, during the last twenty years, been written upon this branch of engineering, but succeeds in showing the desirability of yet another. The point of view is eminently practical—practical, that is to say, with respect to actual processes of design—in evidence of which it may be noted that the first chapter, "External Forces," opens with particulars relating to weights of structures. Any designer of bridges is familiar with the importance of this as affecting the total amount of labour involved in design. Of other external forces stress is laid upon those causing lateral vibration, upon centrifugal force on curved bridges, on braking and traction impulses. With the open floors of American practice these are no doubt of greater relative importance than is the case generally in this country. Some eighty pages are then devoted to the examination of moments, shears and stresses in simple spans and trusses of ordinary type. The method of influence lines is freely applied, which, having regard to the great experience of the author in actual bridge design, may be taken as an excellent tribute to its convenience. Much useful information is given with respect to types of bridges and choice of site, though the author's formulæ for economical spacing of piers is not quite what might be expected—the cost of a pier being assumed a fixed, instead of a variable quantity. The detailed design of floors, beams and plate-girder bridges, and truss spans is given considerable space. Many simple rules are presented for quickly arriving at results frequently needed in the process of design, though the treatment is by no means confined to such minor matters. It is satisfactory to notice that the estimation of shear at the ends of pin-ended compression members is treated in a manner which does not call for question, avoiding an error not uncommon, which makes this quantity little more than one-half its true amount. Latticing for compression members is also considered with respect to large struts of multiple-web type.

Difficulties in the layout of skew spans and bridges on curves get a share of attention. In bridges of this description much labour may be saved in the drawing office, in the shops, and in construction, if care be taken to secure a good scheme in the first instance.

A chapter on viaducts treats the arrangement and design of towers and spans in detail, with consideration of the many extraneous forces, apart from direct load, which in tall and light structures cannot wisely be neglected. The question of weights is again enlarged upon with advantage, particularly with respect to economical layout.

Following a short chapter on elevated railroads, dealing with special problems occurring in this class of construction, there are about forty pages devoted chiefly to movable bridges, for some part of which due acknowledgments are made. The bascule type, traversing, lift and transporter bridges are touched upon, and swing bridges given considerable attention. Points in arrangement and design not usually treated in books on bridgework are noticed, as, for instance, detailed investigation of the resistances to be overcome in operating an opening span and the power plant required for the purpose. Mention is made of the use of gasolene motors, but these, it may be said, unless used to charge hydraulic accumulators, may be found wanting at a critical moment, and are hardly to be approved for such work apart from this qualification. Much information respecting the weights of both the swing and Scherzer type are given, the more useful that it is in works of this class close approximations are not readily arrived at, though of greater importance than in the case of fixed structures.

Over forty pages are appropriated to the consideration of arches of the three and two-hinged forms. This is a most useful section of the book. The author approves the reduction of calculations to reasonable dimensions by eliminating some of the refinements of such computations, as, for instance, in the case of a two-hinged arch, the negligible effect of shear in web members as affecting horizontal reactions, and generally appears to aim at reaching substantially correct results by methods involving a reasonable amount of labour only. There is no suggestion in this that the reader is invited to neglect considerations of importance merely to save trouble, but rather that the author maintains a sense of proportion with respect to the importance of the results to be desired. As in the design of any complex structure of magnitude the difficulty is to make a useful beginning, some little care is taken in the case of the two-hinged arch to show how first approximations may be carried through, followed by figures relating to a particular case more fully stated. Wind stress in arched bridges, the effects

of "braking," the floor system, and bracing generally for such bridges, are dealt with at length, and much information—including weights—given with respect to actual structures. A very useful table of particulars relating to arched bridges gives references to periodical literature, where more detailed accounts may be found—a very thoughtful addition.

A chapter on "Long-Span Bridges"—largely descriptive—is chiefly useful because of the information given as to existing structures, though preceded by pertinent remarks as to choice of type.

Problems occurring in the design of cantilever bridges are dealt with in the concluding chapter of the book, the author introducing special applications of the influence-line method of computation relevant to such structures, and dealing also with the effects of wind and stresses in bracing. Throughout this book there is indeed constant insistence upon the importance of efficient bracing. Many structures have failed for want of this, though it would be difficult perhaps to cite a case in which bracing, even of doubtful value, had any evil effect other than that of enhancing cost, and of introducing, occasionally, ambiguity as to stresses developed in other members. Some, but not too many, pages are given over to miscellaneous information and tables useful to the bridge designer, such as one is accustomed to see in books of American origin. No review of this work would be complete without reference to the set of 52 folding plates provided. These are well worth study, representing as they do a considerable range of work. Marred in a measure by the minuteness and confusion of some of the figures, they are yet of value, and will repay examination—particular attention may be directed to the details of swing bridges illustrated.

The author's treatment of his subject is marked by a broad-minded view of what has been achieved in bridge engineering in various parts of the world, shown by his references to and particulars given of such works, and his bibliographical notes—though here he seems to have missed some writers of outstanding merit. Demonstrations are sometimes, but not always, given of the formulæ or methods displayed. Where reasoning is presented it is very apt to be somewhat meagre, steps in the process not being fully shown; this has advantages—and disadvantages, compelling the reader to do some close thinking on his own part, or leaving him helpless if not able to supply the missing links. The more obscure questions occurring in bridge practice are not dealt with, and it might be well if the author, in a future edition, were to give some indication of their nature, with warnings to the less experienced not to take too seriously results based on such assumptions as want of rigidity at connections of a riveted truss, and other like matters. It may, however, be readily understood that, being himself a designer of work to be carried out, the author appears to have a wholesome regard for methods of calculation leading readily to good results. With a procedure unduly complex, involving considerable work of calculation, much of it mechanical and arithmetical, there is always the danger of errors occurring and evading detection. Simplifying calculations has, then, the advantage—provided there is no sacrifice of essential truth—of reducing such chance of error, and rendering it more readily ascertained should such occur. That such lapses are possible, is evident, but they are the less likely to be committed by those who are most sensible of the possibility and most anxious to reduce the risk.

The book should be useful to the student and to the practising engineer alike—though to each, it may be, in different ways. The diagrams, text, and general character of the book are what might be expected from the publishers.

BOOKS RECEIVED.

The Magnetic Work of the Galilee (1905–1908). By L. A. Bauer, W. J. Peters and J. A. Fleming. Washington: The Carnegie Institution.

Results of Atmospheric-Electric Observations made aboard the Galilee (1907–1908) *and the Carnegie* (1909–1916). By L. A. Bauer and W. F. G. Swan. Washington: The Carnegie Institute.

The Magnetic Work of the Carnegie (1909–1916). By L. A. Bauer, W. J. Peters, J. P. Ault and J. A. Fleming; and *Some Discussions of the Ocean Magnetic Work*. By L. A. Bauer and W. J. Peters. Washington: The Carnegie Institute.

FUEL ECONOMY.

To the Editor of Engineering.

Sir,—The subject of Mr. Samuelson's letter in your issue of July 13 is one of very considerable importance, indeed the subject is perhaps more important than the superficial quantities discussed, because it is really much broader than such quantities merely by themselves convey. All, including laymen, should be grateful to the British Thomson-Houston Company for their pioneering experiments, the ultimate results from which are awaited with interest. In the meantime, I think, it will not be unprofitable to discuss a few of the aspects of the proposition in general, most of which are hardly touched by Mr. Samuelson, and I therefore beg the indulgence of rather a large amount of space. Without either my firm or myself necessarily holding an opinion adverse to the very high-pressure high-temperature (either separately or combined) proposition *per se*, I am compelled for the purposes of argument to adopt a somewhat adverse-looking and critical attitude.

We are led to infer that the 15 per cent. to 18 per cent. gain in economy is entirely due to the very high-pressure high-temperature conditions. I venture to differ. If a boiler efficiency of 80 per cent. to 83 per cent. can be obtained under these conditions there is no reason at all why it cannot with other more moderate conditions; indeed it is rather the other way about, the higher the pressure and temperature the easier is it for both of them to escape their imprisonment. Messrs. Babcock and Wilcox confirm the statement as to efficiency to us. The boiler under almost any tangible conditions is just as likely to improve up to its possible maximum of, say, 85 per cent. to 90 per cent. as is a turbine to its 80 per cent. to 85 per cent. The latter has improved 10 per cent. in the last few years solely due to design, and the same is reasonably to be expected of the boiler. So the increase from about 75 per cent. to the 80 per cent. to 83 per cent. mentioned is in the natural order of things and not peculiar to the high-pressure high-temperature conditions. We are left, then, with about half of the 15 per cent. to 18 per cent. as the power-plant proper's share.

Mr. Samuelson points out that for 175 lb., 800 deg. F., and 300 lb., 500 deg. F., the ratio: heat available in steam/total of heat of steam, is the same. This seems somewhat beside the point. We are more concerned with the next step—the ratio of the respective available heats (or, rather, energy. Why do we all persist in calling our available energy head available heat? No steam engine in the world will run on heat without an essential something else. I even object to the word, although I may show that superheat is more useful than superpressure). For the two conditions the available energies are about 433 British thermal units and 396 British thermal units respectively (they differ between the various charts, but to avoid equivocation it is sufficient to say that whatever the absolute figures may read the relative figures are practically the same for all). Now, as the first-mentioned ratio is the same, with the same boiler efficiency for the two conditions the fuel consumption is the same for the same number of steam British thermal units. Mr. Samuelson leaves us with the idea that the kw. output, in other words, the efficiency ratio of the turbine itself, is the same for the two conditions. Now, no one knows better than Mr. Samuelson that this is not so. The 300 lb., 500 deg. job will be considerably inferior to the 175 lb., 800 deg. For a turbine starting with a velocity compounded stage the dryness fraction in that stage with the former will only be about 0.92 with a velocity of about 2,800 ft. to 3,000 ft. per second, and I think it is the rather common and bitter experience that frightful inefficiency follows on such conditions. With 175 lb., 800 deg., for the same paper velocity conditions, the superheat in the first stage is about 200 deg. F., and the efficiency of that stage will be reasonably high. Possibly the "reaction" turbine people will have something different to say.

Let me put some approximate figures down in parallel columns:—

	175 lb., 800 deg., 28½ in.	300 lb., 500 deg., 28½ in.
Total heat, from 32 deg.	1,414	1,262
Total heat, from 80 deg.	1,366	1,214
Available energy, British thermal units	433	395
Mean temperature at half energy expansion, allowing a general nozzle efficiency of 0.88	390	242
Mean superheat	155	—
Mean dryness fraction	—	0.928
Final dryness fraction	0.925	0.812

Now it is mutually accepted in turbine circles that 40 deg. of superheat gives about 1 per cent. difference in efficiency (apart from the different available energy, if any). There is not, so far as I know, any agreement as to the effect of moisture. On the entropy chart 40 deg. of superheat is roughly equivalent to three points of moisture, and my experience is that it certainly is not less. However, I will take three points, and then we have the difference between the two cases of:—

155 deg. + 40/3 (100 − 92.8) = 251 deg. equivalent superheat, or 6.3 per cent. difference of efficiency, or, say, five points difference of efficiency ratio.

I consider this a minimum value, and should be inclined to put it at double—indeed, I should in a comparative tender.

We have now to balance the coal and the power account. We have:—

	175 lb., 800 deg., 28½ in.	300 lb., 500 deg., 28½ in.
Heat (above 80 deg.)	1,366	1,214
Coal	1	0.89
Available energy	433	395
Efficiency ratio of turbine, say	0.74	0.69
Useful energy	321	272
Power	1	0.85
Coal/power	1	1.047

Thus the high temperature plant has at least a 5 per cent. pull over the high pressure. I have taken the two extreme cases instanced by Mr. Samuelson.

We should now, I think, compare two cases of low and high pressure with the same high temperature, as this is somewhat more pertinent. Let us take:—

	175 lb., 800 deg., 28½ in.	350 lb., 800 deg., 28½ in.
Total heat above 32 deg.	1,414	1,408
Available energy	433	478
Difference	10.4 per cent.	
Mean temperature	390	277
Mean superheat	155	42
Final dryness	0.925	0.882

Temperature difference effect between the two cases = 155 − 42 = 93 deg. = 2½ per cent. efficiency, or, say, 1½ points on efficiency ratio.

Efficiency ratio, say	0.74	0.7225
Coal	1	1
Useful energy	321	345
Difference	7.5 per cent.	

To sum up the above we have:—

(*a*) High pressure only as against high temperature will not do.

(*b*) High pressure combined with high temperature should give a benefit up to a maximum of 7 per cent. over the ordinary pressure of to-day at the same high temperature.

We are then left with the practical questions which time only can answer (I particularly mention this because these answers can never justly come within the range of a contract performance unless manufacturers deliberately force the apparatus upon the public, and I for one would rather adopt the pessimistic view than the optimistic one of Mr. Samuelson—not generally, perhaps, but certainly in a thing of this kind). What is the relative life of the high-pressure high-temperature, low-pressure high-temperature, low-pressure low-temperature plants?—by "low" I mean ordinary 150 lb. to 200 lb., 450 deg. to 550 deg. Five years in the one case instead of fifteen in the other might be a serious matter. What is the relative danger? I am informed by one of the important insurance companies that the rates would be higher, at least until definite proof is established that the risks are no more. Extra premiums, then, are coming in the bill for a time. It may sound something like the ancient objection when pressures advanced from about atmospheric to the enormous value of 20 lb. or so, but it is really vastly different, particularly as the problem is almost as much metallurgical as mechanical.

The high-pressure proposition has also to be considered in relation to load factor, for it does not at all appear that an advantage in evidence at full load continues all the way down the line. Taking a generator of average efficiency the no-load consumption of the experimental turbine only is about 1,500 lb. per hour (2,000 lb. with the generator). There is nothing striking in this: in fact, on the face of it, it seems rather bad with 700 deg. steam. For 4,000 kw., 3,000 r.p.m., about 450 deg. steam, a Belliss and Morcom turbine takes 2,500 lb. at 28½ in.; also a 750 kw., 3,000 r.p.m. mixed-pressure turbine, which has about the same size internals as a 1,500-kw. high-pressure turbine, on live steam takes only 1,250 lb. (unfortunately I cannot produce a 1,500-kw., 3,000 r.p.m. example). Nothing extraordinary is claimed for these figures. Now the no-load consumption is greater with the greater number of stages. For example:—

Turbine of two 46-in. wheels, 1,500 r.p.m., 380 deg. to 400 deg., 28½ in., 400 lb.
Turbine of two 46-in. wheels, 1,500 r.p.m., 380 deg. to 400 deg., 25½ in., 770 lb.
Turbine of two 46-in. wheels and 12 other stages, 380 deg. to 400 deg., 28½ in., 640 lb.
Turbine of two 46-in. wheels and 12 other stages, 380 deg. to 400 deg., 25½ in., 1,050 lb.

Not leaving a big difference for an odd stage, it is true, but nevertheless illustrating the tendency. Therefore the very high-pressure turbine, with its extra stage or diameter, or whatever it may be, will tend to have at least as high a no-load consumption as the moderate turbine. Consequently at half load the benefit from the very high pressure is not more than one-half that at full load, and so on. Ordinarily (not war time) very little power plant runs continuously at full load. It seems to me that although the working load on any one unit in a station may be high, the load factor, which is more often than not on the wrong side of 0.5, or even 0.25, is of more importance the higher the pressure and temperature, because the standing losses by leakage and radiation must in the nature of things be higher. So with a daily average working load of, say, 0.5, and a yearly load factor of, say, 0.2, the maximum possible paper benefit of about 3.8 per cent., with no standing losses, wants looking at twice.

Further, I believe I am pretty safe in saying that the contingent risks of variation in the working economy of any station are greater than 6 per cent. or 7 per cent. It is proverbial that "if it is not one thing it is another." It will at once be said that if we can effect an improvement

of, say, 5 per cent. on the cycle of power generation, we improve 5 per cent. all round. Not at all. A moderate breakdown occasioned directly or indirectly by virtue of the 5 per cent. saver may easily wipe out the whole saving and turn it into a loss. For instance, suppose a ½ lb. reduction in steam consumption (Δc) conduces to a breakdown, we have :—

Saving in coal cost per hour

$$= \frac{(\text{Rating of unit}) \times (\text{a load factor}) \times \Delta c}{8 \times 2240} \times \underset{\text{(steam/coal)}}{10s.} \text{ per ton, say.}$$

Approximate loss per hour, neglecting standing charges and cost of repairs

= Rating × load factor × 5 per cent. (net profit, say) × 1*d.* per unit, say

Ratio of loss/saving

$$= \frac{0.05 \times 1 \times 8 \times 2240}{10 \times 12 \times 0.5} = \frac{896}{120}, \text{ say } 7 : 1.$$

The complicated inclusion of standing charges and repairs only makes it worse.

Thus it behoves us to be very careful over our proposed moves towards economy. It is no national economy for the whole contingent liability to be thrown on the manufacturer. Somebody has to pay for it. Moreover, it is disastrous to throw much on the manufacturer, for he may easily be ruined thereby, when the community would not be. It therefore behoves us to be still more careful in pressing these economy moves on the private customer where there is no opportunity of diffusing the onus. *Per contra*, caution is demanded, despite competition, in taking on guarantees to a customer initiating hot-house schemes.

But another point: By a mere sweep of the pen Mr. Samuelson promises another 3½ per cent. better consumption for his turbine. Why not yet another 3½ per cent.? The efficiency ratio of the experimental turbine at 11 lb. per kw. appears to be 0.723 to 0.735, allowing for the little uncertainty in our steam data; at 10.6 lb. it would be 0.75 to 0.762—shall I say "only"? (These figures may be good ones; but, strange, where have I seen much higher figures than these, and where have I seen those curious lists of figures that occasionally stray across the horizon in which a range of contemporary latest designs have a range of appetite very much greater than 3½ per cent.?) It is more difficult to improve the efficiency of the turbine in the upper regions of pressure than in the lower—at any rate, the 11 lb. consumption looks very much like it—and it is rather questionable wisdom to go to all the trouble of the very high pressure to get a reduction of 7 per cent. in the consumption when possibly 7 per cent. or more can be got by the evolution of design with a more comfortable pressure. Indeed, very small-looking leakages, internally or externally, with such high pressure might soon play havoc with the 7 per cent. And this 7 per cent. is only at full load.

True, for large stations and units there may be a considerable reduction in capital outlay, and even manufacturing convenience on pipes and fittings, by the adoption of very high pressures, but is not the whole point of the proposition an economy in running charges rather than in capital outlay?

The proposition is not unrelated to the power-heating scheme, which is becoming more and more in evidence, so much so that there is considerable support to the prediction that in the future decomposition of coal the production of power will be but one of many by-products and not by any means the most important. As the relative importance of the by-product decreases, so does the need for economies standing on the least precarious ground (please note the qualification). Considering the power-heating scheme for the moment, the temperatures required in industrial heating processes are very various, but it seems that the average temperatures required are from 200 deg. to 350 deg. F. I have come across factories where they say they must not have superheated steam (for no very clear reason), but the majority prefer it. Indeed, except where the steam is used in direct contact with the substance in the process there seems little reason why for a given temperature as much superheat as possible should not be used with, consequently, as low a pressure as possible. Pipes would perhaps be larger—perhaps not, as these things are not the subject of rigid paper laws. Further, the transmission of wet steam is more wasteful than that of dry. Water not only begets water, to put it loosely, but heat is conducted away faster from water than from steam. Without further dilation your readers will perceive in conjunction with my remarks on the progress of the dryness fraction that ordinary pressure high-temperature steam has an advantage over the very high pressure high-temperature.

The power-heating scheme exhibits the enormity of the crime of throwing away, mainly through the circulating water, heat which is of no use to anybody except a few dirty young scrubs bathing in the canal—no less than 7,000 to 8,000 British thermal units out of the 11,000 released from the coal. The 15 per cent. to 18 per cent. mentioned by Mr. Samuelson is a mere bagatelle by comparison, and if means are provided for the useful harnessing of the 7,000 British thermal units it does not matter very much whether it is 7,000, 8,000, or 9,000, because inefficiency in the turbine goes out as heat in the exhaust steam. The capital cost of distributed fluid heating will probably be of the same order as that of distributed power; if so, the prices will be the same. Indeed, it is our problem to make them the same. The sizes of generating plant are unaffected by efficiency, as there are many other items deciding these things, which items are reflected in the load factor, a figure that, as we know, averages about 0.2 or so. It is said that drunkenness is not curable by legislation, it being merely meddlesome. The devouring of 11,000 British thermal units to obtain a useful 2,000 or 3,000 British thermal units is perilously akin to excessive drinking; and let us not wait for legislation to put its just embargo on any and all power stations of the prevailing type where this heat is thrown to waste, but devote our energies to the harnessing of this heat rather than in heroics for a 7 per cent. or less economy at the probable expense of more comfort in life than it creates—except (and possibly not even except) to the man upstairs who conceives the means, but who does not have to stew and risk his life in the working of them nor come in on Sundays to make joints. If these schemes are not for the ultimate amelioration of living, what on earth are they for? If we are not clever enough to convert the energy of combustion directly into electricity, for example, then in the name of commonsense and progress let us get on with devising means for using the latent heat of steam—heating our miserably cold homes, laundries, greenhouses—a thousand things—from the present sources of waste rather than by burning still more coal in an appallingly prodigal way.

Yours faithfully,

Alexander Jude.

Birmingham, August 7, 1917.

CORROSION OF CONDENSER TUBES.

To the Editor of Engineering.

Sir,—The letter of your correspondent, "C. de F. M.," which appeared in your issue of the 3rd inst., is most interesting to me, and no unbiased reader could find fault with most of his arguments, nor avoid an acknowledgment of the care with which he has arrived at his premises.

It cannot be gainsaid that where a statement is made which can be proved to be true by experiment and analysis, it is true. There may be many different points of view on the same matter, and each individual thinker is apt to claim that he alone is right by the same token. The seeming divergence of views, however, cannot alter the fact that every theory sustained by proof of its accuracy must be accepted as correct.

Each of your correspondents prove their case from their own standpoint, therefore each must be correct; and, in justice to both, we are bound to admit that the "electrolytic" and also the "mechanical" theories are proven beyond a doubt to have their part in the corrosion of condenser tubes.

The unfortunate part, from the point of view of the sufferer, is that no two investigators seem prepared to agree with each other, or to admit that the findings of a rival are correct, and it naturally follows that such divergence of view, instead of assisting the research, retards the progress to the goal—the entire elimination of corrosion.

To whom shall we turn when the doctors disagree? Is the poor patient to die? Must it be left to a post-mortem examination to establish the reputation of one at the expense of the others? Would it not be better to admit the obvious, that proof must be proof, and that the seeming divergences of view are only seeming, and that each point of view is one view of a complete whole which is to be overcome by the united efforts of all. Because many points of view exist, it by no means follows that the cure for corrosion is equally complicated; it is, in fact, one of the most simple propositions ever put forward for practical use in conjunction with power production. Corrosion is due to several causes (according to the point of view of different investigators), which can be roughly divided into three, viz. :—

Galvanic.
Chemical.
Mechanical.

From which it would appear that a triple antidote is required, which undoubtedly is the case. For such to be commercially practicable, it is essential that the action should be simultaneous, anything complicated would defeat the object in view and in all probability give more trouble than the disease it was designed to cure.

Yet how simple is the real and only cure—turn your unit into a simple battery, of which it forms the negative pole, at which it has been indubitably established no corrosion can take place; insert in a convenient spot a suitable positive pole, easily renewable and cheap, at which all corrosion takes place, and you have the simultaneous triple antidote which will banish the bogey of corrosion permanently.

Very little energy is required: the attention called for is quite negligible, as is the cost of upkeep, and what are the results? More important still, they have been proved (because if they *have*, then this method must be right).

Manifestly, the results of this method must be as follow :—

Galvanic Action.—This is positively controlled by bringing to bear a higher E.M.F. than any of the galvanic couples present on the surface of the metal to be protected, and by the transference from the unit (now wholly negative) to the inserted positive the whole of the corrosive action due to these couples.

Chemical Action.—The action of a weak current has the effect of decomposing the liquid (which acts as an electrolyte), and of forcing to the respective poles the negative and positive radicles of the foreign elements in the liquid, which are the cause of scale formation, such division rendering them innocuous and easily dealt with.

Mechanical Action.—Any schoolboy knows the mechanical effect produced at the opposite poles of a wet battery, *i.e.*, that one of oxygen is given off to the positive pole, and two of hydrogen at the negative pole; applying this to the argument, it is obvious that there must be a constant film of hydrogen evolved over the whole of the immersed surface of any unit to which this method is adapted, and this is of sufficient volume to remove any air bubbles that may be trapped by the irregularities of the surfaces, and, furthermore, the galvanic action has the effect of driving to the positive pole, not only oxygen, in whatever form it may be present, but also acid, grease and other impurities, which are the cause of so much trouble.

Some ten years practical proof of the method of overcoming corrosion here described is on record. Can practical proof be gainsaid? Possibly the point of view here set forth has not occurred to "C. de F. M.," but it is one which, the more it is examined, the more convincing it will appear, and if "C. de F. M." will investigate further on more extended lines, he will be satisfied with the result.

Yours faithfully,

Elliott Cumberland.

6, Lloyds-avenue, London, E.C. 3, August 14, 1917.

WANTED: A NATIONAL ASSOCIATION OF ENGINEERING FOREMEN.

To the Editor of Engineering.

Sir,—In support of the correspondence in Engineering of July 27 and August 10 please permit me to say a few words. Many foremen feel that they are being tyrannically treated, financially and otherwise, due to the Prussian methods of the Government, who have not only given the power to any unscrupulous employer, through the hated leaving certificates, to practically prevent a foreman leaving to enlarge his scope, but who also conveniently forgot the existence of foremen when they gave the advances totalling 15*s.* per week as war wages to engineering workmen. Apparently, even with all the unrest existing, our "out-of-touch" Government despise foremen just as if they were only a buffer between employers and employed; and yet they have direct charge of the workmen and have heavy responsibility in the technical part and costing part of engineering war work, and also the directing and teaching of diluted labour falls especially heavily upon them.

For the past two years a foreman has not had the potent weapon of "the sack" in his hands when handling his men, the men, as well as he, knowing full well that the leaving certificate prevented him from getting men from elsewhere to replace them, and he has had to discipline his men almost entirely with tact and his own personality. The spirit existing amongst many workmen has been to welcome "the sack" with open arms, as it gave them much wider opportunity to choose their job since the leaving certificate came in vogue, some trying all sorts of subterfuges and ca' canny methods in order to get away, and in ways that could not be taken to court.

The additional work thus given to foremen, and also the almost doubled cost of living, has been met by some employers with nothing extra in wages, or else small doles, and has begun to make foremen quite indifferent to the spirit of unrest amongst workmen—which many foremen have tried patriotically to allay in the past—and to drift into a similar spirit themselves. I venture to say that there will be open revolt amongst many workshop foremen if the Government do not remove the inquisition of the leaving certificate from us and give us at least the same rights as they have promised to give workmen when desiring to change employment.

The past two years' experience shows that other bodies of people, to obtain what they claim as their rights from the Government, have had to be combined, in order to create a riot, or to strike, or do something drastic and often unpatriotic in order to kick the Government out of their inertia, and their faculty of uselessly riding roughshod over sections of people who, without combination, are not powerful enough to convince some of the Government "Jacks-in-office" that war-necessity laws that they may make are not always the perfection of wisdom, and often still less of experience.

I trust that the effort now being suggested to form a National Association of Engineering Foremen—not necessarily on trade union lines—will be taken up vigorously, especially with some of the larger local foremen's engineering associations to co-operate and take immediate action with the Government regarding the leaving certificates and our interests generally.

Yours faithfully,

August 12, 1917. "Workshop Foreman."

German Aeroplanes.—According to *The Army and Navy Gazette* the Gotha biplanes exhibit a marked resemblance in certain particulars to one of our best-known large aeroplanes. They are about 40 ft. in length and of the "pusher" type. The wings are nearly equal in span (about 77 ft.), with projecting ailerons, and are at a very slight dihedral angle. The gunners, both front and rear, can fire downwards and upwards, as well as on their own level or right and left, and the bottom of the fusilage is open for a great portion of its length, which enables the gunner to fire at a pursuer either over the top of the fusilage or through the tunnel formed by the fusilage, and both gunners can also fire downwards through trap doors. The aeroplane carries a crew of three; the armament consists of three machine guns. It cannot be approached from any direction without the adversary coming under the fire of one or other of its three guns. In fact the adversary who comes at the aeroplane from the rear is likely to meet the concentrated fire of two machine guns. The first gunner sits nearly in the centre line of the machine, but the pilot is placed on the left, there being thus a passage on the right which enables the gunner in front to move to the back and work the second of the two guns in the rear.

MULTIPLE-ARCH DAMS ON RUSH CREEK, CALIFORNIA.*

By L. R. JORGENSEN, M.Am.Soc.C.E.

Introduction.—During the last few years several multiple-arch dams have been built in the United States, and, thus far, have been very successful in operation. Undoubtedly many more would have been constructed had a thorough knowledge of their design and construction been more general among dam-building engineers. There are places where rock or earth fill dams, or a combination of the two, are now built, where multiple-arch dams could have been constructed more economically, and they would have been more substantial.

Although, under ordinary conditions, a rock or earth fill dam can be constructed with a sufficient, although unknown, factor of safety, such dams are absolutely unsafe under abnormal conditions, such as when water accidentally passes over the crest. It is a well-known fact that nearly all failures have been due to this cause. Water passing over the crest of a multiple-arch dam would not destroy it, and, for a more or less limited time, would not hurt the foundation, if this was otherwise at all safe for such a structure. A multiple-arch dam requires a good foundation, as the load is concentrated on the buttresses, and settlement of these would be likely to cause the collapse of adjoining arches. Whenever the foundation is solid rock, however, a multiple-arch dam can be constructed, and will be as substantial as any and more substantial than most types. The stresses and dimensions can be calculated with great accuracy. The factor of safety of such a structure, therefore, is known within narrow limits, assuming first-class construction, and on that account precedents should not be given so much consideration as with rock and earth fill dams. These latter cannot be subjected to calculation of stresses, and therefore have to be built mostly along lines dictated by precedents. In general, it can be said that a multiple-arch dam of small and medium height (less than 100 ft. high) will cost less to construct than a rock-fill dam, especially if the latter is provided with something better than a wooden up-stream face for the watertight cut-off.

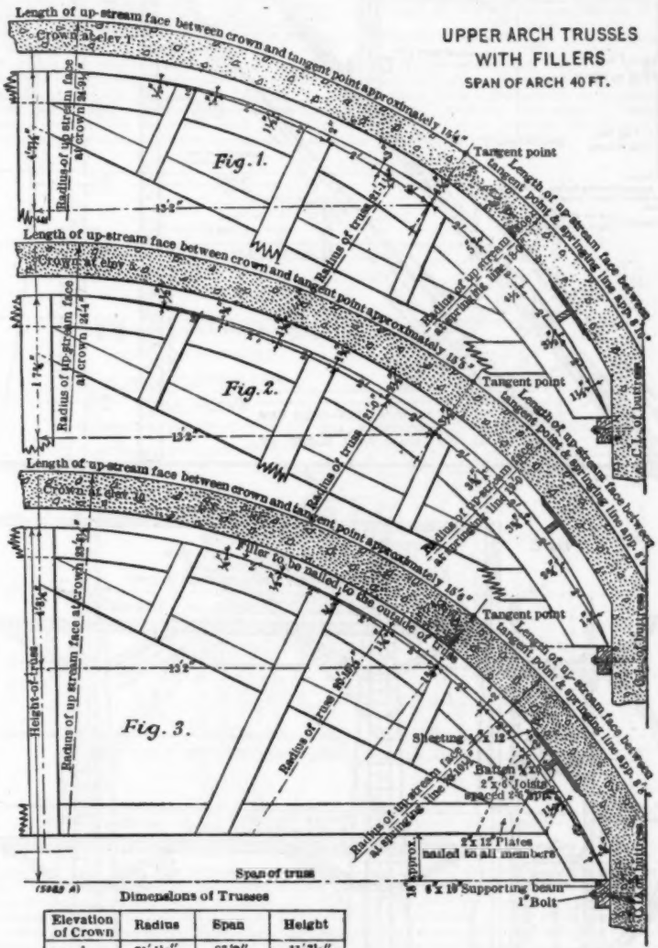
* Paper (slightly abbreviated) read before the American Society of Civil Engineers.

Perhaps only in rare cases would there be occasion for comparing the relative costs of a multiple-arch and a strictly earth-fill dam, because, if there is enough suitable earth to construct an earth dam, a sufficiently good foundation for a multiple-arch dam and sufficient good building material for such a dam are not likely to be found at the same place, and *vice versa*.

For a multiple-arch dam higher than, say, 130 ft., the quantity of building material required, and therefore the cost of such a structure, increases quite rapidly, due mainly to the fact that the buttresses become very large and require more bracing. Eventually, therefore, a limit of height is reached where it will be more economical to build a single arch across the canyon, unless the latter is very wide. This limit of height for any dam can only be found by trying all the types possible of application, as the shape of the dam site has also quite an influence on the design.

The Design of the Multiple-Arch Dam.—The first thing to be determined is the length of each individual span. Unless there should be strong reasons for using different span lengths for the several arches making up the complete structure, all spans should be the same, in order to facilitate the form work. Theoretically, the shorter the spans, the less the material required for the arches. The material required for the buttresses remains theoretically the same, no matter what length of span is chosen. Although a dam consisting of small spans takes less material than one where the spans are larger, the cost of construction may not necessarily be less. The form work becomes more extensive, and it is more difficult to place the concrete and reinforcing steel in the resulting narrow space between the form boards than in a wider space. Thin arch walls are more likely to collapse than thicker ones, and thin buttresses would require elaborate bracing in order to prevent their collapse long before their crushing strength had been reached. It is the arch that holds the water back, and therefore the water-tightness of the dam is to some extent a function of the thickness of this wall, although to a much larger extent it depends on the quality of the building material (concrete) used.

Taking all these facts into consideration, it may be stated that the practical and most economical span lies between the limits of 30 ft. and 50 ft. For high dams the economical span is near the upper limit; for low dams it is near the lower limit. A 40-ft. span would be a good average value for ordinary cases, and is chosen in the present instance.


UPPER ARCH TRUSSES
WITH FILLERS
SPAN OF ARCH 40 FT.
Fig. 1.
Fig. 2.
Fig. 3.
Length of up-stream face between crown and tangent point approximately
Crown at elev.
Radius of up-stream face at crown
Tangent point
Length of up-stream face between tangent point & springing line
Radius of up-stream face at springing line
Radius of true
Filler to be nailed to the outside of truss
Height of truss
Sheeting
Batten
2" x 6" joists spaced 2½" apart
5" x 12" Plates nailed to all members
Span of truss
Dimensions of Trusses
6" x 10" Supporting beam
1" Bolt

Elevation of Crown	Radius	Span	Height
1	21′ 1⅛″	37′ 8″	11′ 7⅛″
5	21′ 0″	37′ 6⅛″	11′ 7⅛″
10	20′ 10½″	37′ 4⅛″	11′ 7¼″

The next feature to be determined is the length of the up-stream radius. It is known that the most economical arch* is the one that subtends an angle of 133½ deg., and that for variations of about 10 per cent. on each side of this angle the difference in economy is very small. For the dams to be described later the subtended central angle at the up-stream face is 120 deg., or, to be exact, 119 deg. 57 min. The volume of the arch has thereby been increased approximately 1 per cent. above the theoretical minimum, but, at the same time, the thickness has been increased 6 per cent., thereby decreasing the ratio of thickness of arch to length of arch, which, for structural reasons, is a desirable feature, at least toward the crest, where the thickness is small compared with the length. This also decreases the probability of percolation by decreasing the area of the wetted surface, and by increasing the thickness of the wall.

With the subtended angle (120 deg.) and the span (40 ft.) decided, the length of the up-stream radius is calculated to be 23.1 ft. To facilitate form work, the length of this radius is kept constant from crest to foundation, except as noted later. Incidentally, this gives also the most economical arch, as the subtended angle is thereby kept practically constant. The arch is given a slope with the horizontal of 50 deg., in order that the water pressure, acting on the vertical projection of this slope, may tend to cut down the shearing stress on the buttresses to zero, or to some insignificant value.

The arch carries the total water load and a large part of the load due to its own weight. A preliminary arch thickness may be found by the simple formula

$$P \times R_u = q \times t \quad . \quad . \quad . \quad (1)$$

in which P equals the water pressure, in pounds per square foot; R_u equals the length of the up-stream radius, in feet; q equals the average stress, in pounds per square foot, of the area of the dam section under consideration; and t equals the thickness of the dam, in feet, at any given horizontal elevation.†

After the thickness, t, has been determined, at as many points as thought necessary, say every 10 ft. apart in elevation, the weight of the arch can be calculated and the additional arch stress due to this load determined. If the total stress is found to be excessive, a new thickness will have to be chosen.

Due to the inclination of the arch, the water pressure is not distributed uniformly between the crown and the abutments on any imaginary arch slice perpendicular to the slope. As the crown is at a higher elevation, it sustains less water pressure than corresponding points at the abutments.

For the case under consideration—where the length of the up-stream radius is 23.1 ft., the subtended angle is 120 deg., and the inclination of the arch is 50 deg. with the horizontal and 40 deg. with the vertical—a point at the crown will always be

$$\frac{R_u}{2} \times \sin 40 \text{ deg.} = 11.55 \times 0.64379 = 7.424 \text{ ft.}$$

above a corresponding point at the springing line. Toward the crest this difference in elevation makes a large difference in the distribution of the load on the face of the arch, and therefore, also, in the location of the line of pressure in the arch ring. Take, for instance, an arch slice 1 ft. wide, with the middle of the crown at elevation 5, and with the middle of this slice at the springing line at elevation 5 + 7.424 = elevation 12.424. With the reservoir full to the crest the water load at the middle point of the crown would correspond to 5 × 62.5 = 312.5 lb. per square foot, whereas the water pressure at the corresponding point at the springing line would correspond to 12.424 × 62.5 = 776.5 lb., or nearly 2.5 times more than at the crown.

At lower elevations this large difference (2.5 times) rapidly grows less, and becomes unimportant with crown elevations below elevation 15. In the upper portion of the dam the radial component of the arch weight borne directly by the arch itself tends to neutralise the large difference in water pressure between the crown and the corresponding abutment points, as this weight component has its largest value at the crown and its smallest value at the abutments. This can be shown most clearly by a graphical method, in which two arch slices are drawn, each assumed to be 1 ft. wide. In the first the middle of the crown is at elevation 5, and then a width of 6 in. is taken on each side; and in the second the crown is at elevation 10. The arch is divided into 20 voussoirs, and the forces acting on these voussoirs are calculated. These forces, though not distributed uniformly, are, of course, symmetrical on both halves of the arch with respect to the centre line between two buttresses.

On the right half of each diagram will be shown the weights of the different voussoirs resolved into their components. The weight of a voussoir is partly transmitted to the base through the lower portion of the arch, and partly supported by the arch. The last component is equal to the total weight of the voussoir multiplied by cos 50 deg., and is set off vertically, acting through the centre of

* Further information in reference to this may be found in Transactions, Am. Soc. C. E., vol. lxxviii, Paper No. 1,322, pages 689 to 690.

† The thickness of any horizontal arch slice (elliptical with major axis = $\frac{R_u}{\sin. 50 \text{ deg.}}$, and with minor axis = R_u) is made constant from abutment to abutment, and therefore the circular arch perpendicular to the slope must have its thickness increase from the crown toward the abutments.

gravity of each voussoir. This vertical load is resolved into one radial component and one perpendicular thereto. The radial component can now be added directly* to the water load on the same voussoir, which, of course, is also radial. The geometrical sum of the last-named (perpendicular) components represents the increased axial stress toward the abutments.

On the left half of each diagram the total radial forces acting on the different voussoirs will be indicated. A polygon of forces is drawn, and by using this the line of pressure of the arch can be determined by drawing lines parallel to the proper rays in the polygon of forces. It will be plainly seen that the line of pressure lies decidedly outside the centre line of the arch; especially is this true of the arch with its crown at elevation 5.

Using these diagrams, the correct shape of the wooden arch trusses supporting the form work for these upper elevations can be ascertained. The outside members of these trusses are made elliptical above elevation 15, as shown in detail in Figs. 1, 2 and 3, in such a way as to bring about coincidence between the line of pressure and the centre line of the arch. At elevation 15 the centre line of the arch and the line of pressure do not exactly coincide, but they are close enough together to allow the circular shape of the arch to be used with entire safety. Below elevation 15 the arch is made circular in a plane perpendicular to its sloping axis, and above elevation 15 it is made elliptical in accordance with the diagrams, or a slight modification thereof, depending on how far below the crest the maximum water-level is to be. It might not be out of place to state here that J. S. Eastwood, M.Am.Soc.C.E., who has been very prominent in bringing into actual use the multiple-arch type of dam, builds the top portion of the arches vertical, whereby the circular shape can be used for the entire arch.

Stresses Due to Temperature Changes.—As dams are generally built during the summer season it is only logical to assume that after their completion the individual arches are under tensile stress most of the time when the reservoir is empty, and decidedly so if it is empty during the cold season. The reinforcement in the arch, therefore, has been placed with the sole purpose of taking up these tensile stresses, which reach their maximum value near the down-stream face at the crown, and near the up-stream face at the abutments, under the conditions just stated. From the drawing at the left of Fig. 4 it will be seen that the reinforcing steel is placed at a distance equal to one-fourth of the total arch depth from the respective faces subject to tensile stresses, at the crown and at the abutments. The quantity of steel in the arch is perhaps not entirely sufficient to take care of the maximum condition of temperature drop, but it is believed that if tension cracks develop the presence of the reinforcement will cause them to be minute and well distributed, and that when the structure becomes loaded the cracks will close tight. It was not deemed advisable to put in the arches more steel than that shown by Fig. 4, for the reason that it is of comparatively little use when the reservoir is full. It was also kept in mind that a large change in temperature is not likely to occur suddenly, as a time element of perhaps weeks or months is generally interposed between the occurrence of maximum and minimum temperature in a dam body. This time factor can be depended on, to some extent, to prevent or minimise temperature cracks. It gives the modulus of elasticity time to adjust itself to the new condition (colder or warmer concrete).†

The Stability.—After the buttresses have been given some preliminary dimensions the stability of the whole structure can be investigated, most conveniently by a graphical method, as shown by Fig. 6, representing a section through the crown of the arch. To facilitate the investigation the dam is divided into horizontal sections, 10 ft. apart in elevation, and the forces acting on and above each section are shown to scale in the location and direction in which they act.

The most important force acting on the structure is the water pressure, and this, as usual, is assumed to be concentrated in a horizontal plane which is two-thirds of the total depth below the water surface.

The horizontal plane in which water pressure is assumed to be concentrated intersects the up-stream face along an elliptical curve. The point of application of a single force representing the water pressure on one total span of 40 ft. coincides with the centre of gravity of this ellipse, at least as long as the water pressure does not penetrate the up-stream face skin, such as plastering, &c.

Due to the fact that the arches have been given a slope of 50 deg. with the horizontal, the water pressure will have a vertical component $= \frac{\text{horizontal component.}}{\tan 50 \text{ deg.}}$ To a very great extent the stability of the dam depends on the presence and action of this component, as it tends to hold the structure firmly down on its foundation.

The point of application of the water pressure, as already stated, is taken at the centre of gravity of the ellipse. From the crown this is a little more than one-third of the total distance ($\frac{1}{3} + 5$ per cent. for present conditions) between the crown and the springing line.

Considering first the upper 10 ft. of the dam, the horizontal plane in which the water pressure can be assumed to be concentrated is at a distance of $\frac{2}{3} \times 10$ from elevation 0 downward, with the water surface at elevation 0, and the point of application a of the single force is

$$\left(\frac{1}{3} + \frac{1}{500}\right) \frac{11.55}{\sin 50 \text{ deg.}} = 5.78 \text{ ft.}$$

from the crown, measured horizontally.

The horizontal water pressure due to the 10 ft. of water on the 40-ft. span is

$$\frac{0 + 625}{2} \times 10 \times 40 = 125000 \text{ lb., or } 62.5 \text{ tons.}$$

The vertical water pressure is equal to $\frac{62.5}{\tan 50 \text{ deg.}} = 52.5$ tons. This latter force is now combined with the portion of the weight of the arch acting vertically. The weight of the arch above elevation 10 is equal to its volume in cubic feet multiplied by the weight of 1 cub. ft. The centre of gravity of the section—a trapezoid—is found, and the centre of gravity b of the whole arch is then taken to coincide with the centre of gravity of an ellipse through the centre of gravity of the section, in the same manner as explained previously for the water pressure. The weight of the arch is now combined with the vertical component of the water pressure, and the location of their resultant is found by taking moments around either point a or b. The numerical value of the resultant is equal to the sum of the two forces, $52 + 52.5 = 104.5$ tons. Taking moments around the point a, and scaling the distances, preferably on the sloping line between a and b for greater accuracy, we have the equation $\frac{52 \times 2.75}{104.5} = x = 1.367$ ft., giving the location of the resultant at a point 1.367 ft. from a along the line between a and b. The weight of the buttresses (above elevation 10) assumed to be concentrated in the centre of gravity d is calculated to be 14.5 tons; it is combined with the vertical load of 104.5 tons on the arch, in the same manner as shown previously, by taking moments around any point, say c. The location of the resultant is found to be at e, and its value is $104.5 + 14.5 = 119$ tons. This represents the total vertical force, both as to size and location.

This force is now combined with the horizontal water pressure of 62.5 tons, and the resultant is drawn. It is the purpose of this diagram, Fig. 6, to give the value of the resultant of all forces, and to establish the point of intersection, g, between this resultant and the base, in

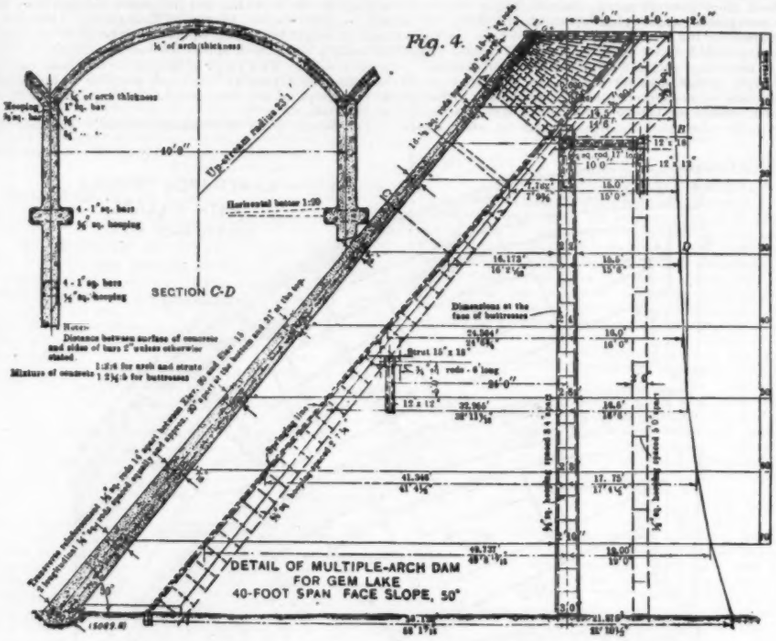


Fig. 4.

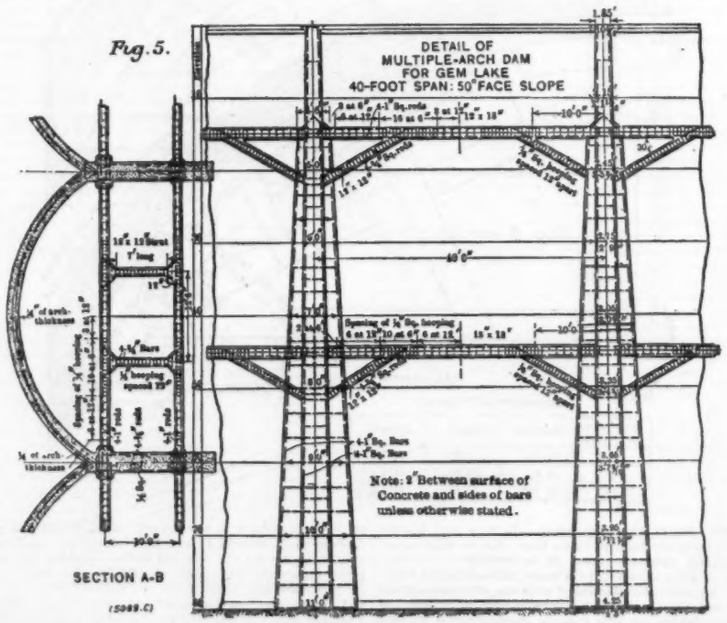

DETAIL OF
MULTIPLE-ARCH DAM
FOR GEM LAKE
40-FOOT SPAN: 50° FACE SLOPE
SECTION A-B
Note: 2" Between surface of Concrete and sides of bars unless otherwise stated.

Fig. 5.

* For greater accuracy this force should be multiplied by the ratio $\frac{\text{length of mean radius}}{\text{length of up-stream radius}}$. It has been neglected in the present case, as this ratio is very close to unity.

† That the deformation of concrete increases under sustained load has been shown by tests and in practice. Two papers on the subject were read at the twelfth annual convention of the American Concrete Institute, in Chicago, one by A. H. Fuller, M.Am.Soc.C.E., and C. C. More, Assoc.M.Am.Soc.C.E., entitled "Tests Showing Continued Deformation under Constant Load," and one by Mr. Carl B. Smith, entitled "The Flow of Concrete Under Restrained Load." This was abstracted in *The Engineering Record*, March 4, 1916, page 329. See also "The University of Minnesota Studies in Engineering, No. 3," by F. R. McMillan.

this case at elevation 10. For convenience the distance from e to f, representing the total vertical force of 119 tons, may be measured, and the distance f–g, representing the 62.5 tons horizontal water pressure, may be set off on the base to the same scale.

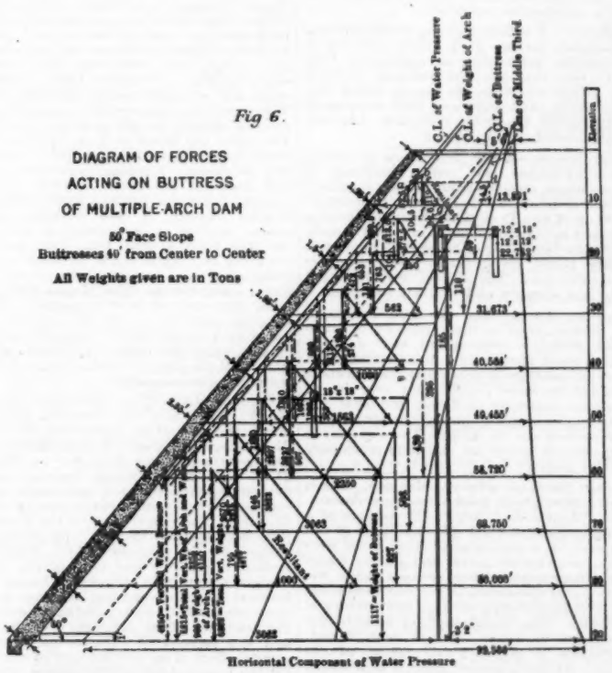
Consider next the portion of the dam above elevation 20 as a whole. The place of application of the concentrated water pressure is at a distance of $\frac{1}{3} \times 20$ ft. below elevation 0, and the point of application of a single force representing the water pressure on the 40-ft. span is located the same as before, 5.78 ft. from the crown toward the springing line, measured horizontally. The vertical component of the water pressure = horizontal component $\div$ tan 50 deg., acting on the arch between elevations 0 and 20, is now combined with the weight of the arch lying between elevations 0 and 20, and their resultant is drawn in the correct location, found by taking moments as shown previously. This resultant is again combined with the weight of the portion of the buttress lying between elevations 0 and 20. The shape of the buttress is taken as that of an obelisk, and its volume and the location of the centre of gravity are found from ordinary rules applying to such bodies. The weight of the struts and counterforts is to be added to the weight of the buttress, whereby the location of the centre of gravity might be slightly changed.

The resultant of all vertical forces acting on the dam above elevation 20 can now be found, both as to size and location, and combined with the horizontal water pressure, whereby the point of intersection of the resultant with the base at elevation 20 is determined.

Fig 6.

DIAGRAM OF FORCES ACTING ON BUTTRESS OF MULTIPLE-ARCH DAM

50° Face Slope
Buttresses 40' from Center to Center
All Weights given are in Tons



The same method of procedure is followed for the remaining portion of the dam, each time taking the base 10 ft. lower than in the preceding calculations, and the whole diagram, Fig. 6, is completed. If now the centre line of the buttress, and also the two lines representing the middle thirds, are drawn, this diagram will point out very clearly whether or not the load is distributed economically on the buttress. For maximum economy the resultant of all forces should intersect the base in the centre line of the buttress; then the load will be distributed uniformly over the whole base. Toward the top this is not quite possible, and is not important, as the material there cannot be stressed very highly at any rate; but toward lower elevations the down-stream slope of the buttress should be shaped so as to conform with this condition, viz., the resultant intersecting the base in the centre line, or approximately in the centre line, of the buttress. The total vertical load on the section shown in Fig. 6 is seen to be 6,332 tons, and the horizontal water pressure 5,062 tons, both on a 40-ft. span. If the coefficient of friction is taken at 0.75, it is seen that the actual shear along the base amounts to only 5062 — 6332 = 313 tons. There is considerable steel in the section to help take up this shear, and therefore it was not deemed necessary to eliminate the shear entirely. There is no hydrostatic uplift to amount to anything acting on a dam of this type, and water could hardly find its way to lubricate the surfaces of possible cracks in the buttresses. Wherever it would be desirable to eliminate the shear entirely the face slope should be made flatter, say 45 deg. instead of 50 deg. This of course adds to the material required for construction, but is the cheapest and best way of accomplishing the result.

Some difference of opinion may well exist as to the actual stress per square unit of area of the buttress at any horizontal elevation. The loads per buttress are given on Fig. 6. For instance, at elevation 80 the vertical load is seen to be 4,977 tons, and the horizontal load 4,000 tons. As the horizontal area is 360 sq. ft. the unit vertical stress should be $\frac{4977}{360} = 13.82$ tons per square foot, or 192 lb. per square inch. The shear would be a little more than friction alone would take care of, but steel is provided for the remainder. The resultant of the two forces (horizontal and vertical) intersects the base 2 ft. down stream relative to the centre line, but on account of having the counterfort (20 sq. ft.) on this side of the centre line also, the stress is actually distributed uniformly. Now, if, instead of the two principal forces, their resultant is used, assuming it as acting on a number of steps perpendicular to the direction of this force (the resultant), the apparent unit stress will be much higher. Thus the resultant (6,385 tons) acting on an area equal to the sum of all the steps (360 × sin 51 deg. 13 min. = 280 sq. ft.) will produce a compression equal to $\frac{6385}{280} = 22.8$ tons per square foot, or 317 lb. per square inch.

There is a great difference between 192 lb. and 317 lb. per square inch. The actual unit compression will be somewhere between, undoubtedly depending on the relative value of the modulus of elasticity of the concrete for compression and for shear. It is seen that the first method, using the principal forces, gives the maximum possible shear that could occur, and that the other method gives the maximum possible unit compression that could occur. None of these methods is very satisfactory, as none fixes the absolute value of stress within narrow enough limits, but the writer knows of no better at present.

The reinforcing steel embedded in the buttress is put there for different purposes. Along the up-stream slope the triangular steel construction shown in Figs. 4 and 5 ties the adjacent arches into the buttress. This is desirable on account of the fact that, in order to facilitate construction, the buttresses are built first and the arches later. The hooping that interconnects the different bars is simply left protruding through the concrete of the buttress at the time this is built. Should one arch fail, this triangular girder would immediately take up the unbalanced thrust and prevent adjacent arches from collapsing, and this is its principal duty. Besides this, however, the steel is active in preventing cracks in the buttress and in taking up some shear. Toward the down-stream edge of the buttress four vertical rods are embedded in the concrete for the purpose of stiffening it, preventing cracks, and taking care of wind pressure. Toward the middle portion reinforced counterforts are constructed for the same purpose. These are still more effective in accomplishing this, due to the greater distance between the pairs of steel rods. All material in the counterforts supports load the same as the buttress itself, but the counterforts, at the same time, are most effective in stiffening the large flat slab (buttress), so that fewer struts are required.

Toward the top of the buttress (at elevation 15) two horizontal struts are tied to the vertical reinforcement (Figs. 4 and 5). These two struts are designed so that, besides their main purpose of holding the upper portion of the buttress in place, they are capable of supporting a light roadway. At elevation 45 another strut is placed near the up-stream face, mainly in order to support the triangular girder, should the latter ever be required to support any unbalanced arch pressure. All struts are able to withstand tension as well as compression, as can be judged from an inspection of the details on Figs. 4 and 5.

(To be continued.)

RAPID BLAST-FURNACE CONSTRUCTION.—We read in *The Iron Age* that the Cambria Steel Company, on July 3, blew in the blast-furnace No. 11 at Johnstown, Pa., just 57 days after work on the stack began. The foundation was already in place at that time. This makes a new record for blast-furnace construction, the former record having been attained on June 5, 1916, when the same company completed a blast-furnace at Johnstown in 85 days.

GERMAN SHIPPING.—The large Ruhr firm of Hugo Stinnes has become further interested in shipping, having acquired the shipping concern of H. W. Heidmann, whose boats have hitherto been entirely employed in the import of coal. The old Franz Lemm yard at Boitzenburg, on the Elbe, has been sold to a Hamburg syndicate, with a view to extending the activity to the building of sailing vessels with motors; the construction of river and coasting boats has hitherto been the yard's speciality.

ELECTRIFICATION OF THE GOTTHARD RAILWAY.—In view of the difficult conditions under which the Gotthardbahn has to work, the administration of the S.B.B. (Swiss Federal Railways) has resolved to apply for a credit of 2,030,000 francs for the construction of four trial electric locomotives, which are to be tested thoroughly before the final design is decided on. The locomotives are to be run on the Scherzlingen–Spiez–Brig section of the Lötschberg railway, which resembles the Gotthard railway in the general condition of the track. The experience already gained on the Lötschberg line is not considered sufficient, therefore. The four trial locomotives are to be of three types, and to be supplied by Messrs. Brown, Boveri and Co., the Maschinenfabrik Oerlikon, and the Lokomotivfabrik Winterthur.

BREAKDOWN VAN OF THE ENGADINE RAILWAY.—The *Schweizerische Bauzeitung*, of July 14, illustrates the new breakdown van which was constructed for the Engadine branch of the Rhaetian railway, and which has been in use since November, 1916. The car is built of steel, with wooden panels, 35 mm. thick; the length is 13 m., the height 3.4 m., and the total weight 14 tons, with full equipment 23 tons. The car runs on two bogies with four axles in ball bearings. Entrance is from the platform at the one end; the other end is closed by a double door, which can only be opened from the inside when the car is at rest, and serves for pushing out (or pulling in) heavy tools and parts by the aid of a roller near the door. There are sliding doors in the sides. The unusually complete equipment comprises chain pulleys, rails and rail-shoes, heavy and light winches, jacks and traverses for getting engines on the track again, spare parts, telephone wire and contact hooks, acetylene torches, various signal appliances, 20 m. of fire-extinction hose, &c. A cooking stove is in the van; a passenger carriage always accompanies the van.

DETERMINING THE COINCIDENCE OF PERIODIC PHENOMENA.—In the *Comptes Rendus*, vol. 162, page 194 (January 31, 1916), A. Perot described a very sensitive method for determining the coincidence of two periodic phenomena within an accuracy of 0.000004 second. The arrangement is intended for instruments like two pendulum clocks which can close a contact and which differ only a little in period. The circuit of a battery is divided into two branches; the one branch contains contact C, and the primary P_1 of the telephone T_1, the other branch contact C_2 and the primary P_2 of telephone T_2; in the common return to the other terminal of the battery a condenser is inserted. The condenser is charged by the current in that branch which is first closed. When the two circuits are closed at exactly the same moment, both telephones will sound with equal intensity; when there is a slight lag in the second branch, telephone T_2 will sound less loud. The above-mentioned sensitiveness is claimed by Perot himself. In order to provide for a gradual discharge of the condenser, it is shunted by a resistance of some tens of thousands of ohms.

DECLINING GERMAN COAL IMPORTS TO SWEDEN.—Concern is felt in Sweden on account of the very marked decline in the arrivals of German coal, the more so on account of the difficulties of obtaining coal from England. During the months of April and May this year the imports into Sweden of German coal amounted only to 90,000 tons and 170,000 tons respectively, against 482,565 tons and 536,095 tons for the corresponding months of the previous year. The aggregate imports into Sweden for the first five months of the present year amounted to 467,383 tons, against 2,097,598 tons for the corresponding period of 1916, a reduction of some 78 per cent. At the same time prices have risen very materially, the average price per ton in German port for April and May, 1917, amounting to 80.8 marks and 85.3 marks respectively, against 48.9 marks and 49.1 marks per ton for the two corresponding months of 1916. These figures bear out the fact, which has become apparent in other directions, that no small scarcity of coal prevails in Germany, owing no doubt to lack of suitable labour, for as Germany is in need of several Swedish commodities, she is probably doing all in her power to accommodate Sweden.

COLONIAL AND FOREIGN ENGINEERING PROJECTS.

We give below a few data taken from *The Board of Trade Journal* on several colonial and foreign engineering projects. Further information on these can be obtained from the Department of Commercial Intelligence, 73, Basinghall-street, E.C. 2.

Australia.—With reference to the projected manufacture in New South Wales of steel wheels, &c., the Sydney Office of H.M. Trade Commissioner in Australia now reports that the company undertaking this enterprise has been registered in Sydney under the title of Commonwealth Steel Products, Limited, with a nominal capital of 250,000*l.*, of which permission to use 100,000*l.* immediately has been granted. The company intends to erect modern workshops and plant at Newcastle for the manufacture of railway wheels and axles, roll-spring steel, steel castings, and other similar products. Supplies of steel will be obtained from steel works in the vicinity. It is anticipated that the company will commence operations in about eighteen months. *The Commonwealth of Australia Gazette* publishes a call for tenders by the Department of the Navy, Melbourne, for the supply and delivery of auxiliary machinery for Flinders Naval Base, Victoria. Sealed tenders, on the proper forms, will be received, up to noon on October 24, by the Director of Navy Contracts at the Navy Office, Melbourne.

New Zealand.—With reference to the call for tenders by the Canterbury University College of Christchurch, N.Z., for heating, lighting and power plant, H.M. Trade Commissioner in New Zealand reports, under date June 7, that the board of the college has decided to defer the installation of this plant until the end of the war, consideration having been taken of the probable inability of British firms to give a definite promise of delivery within a reasonable time.

Chile.—The Acting British Consul at Santiago reports that a Decree (No. 1,359), dated June 22, has been issued calling for tenders for the improvement of the port of Antofagasta. By the terms of this Decree the amount to be expended on this work must not exceed 1,700,000*l.* In addition to tendering for the work, firms interested may at the same time present tenders for taking up the loan for the above-mentioned sum. Details of the work to be performed and the conditions of contract may be obtained from the Port Commission Offices in Santiago, and copies are expected to be received shortly at the offices of the Chilean Legation in London, 22, Grosvenor-square, W. 1. Tenders will be received up to 3 p.m. on March 30, 1918, by the Minister of Finance, Santiago.

South Africa.—With reference to the new water supply projects for East London and other South African towns, H.M. Trade Commissioner in South Africa reports, under date June 25, that the ratepayers of East London have adopted the scheme for taking water from the Buffalo River, as proposed by the consulting engineers. H.M. Trade Commissioner in South Africa has forwarded, under date May 22, a copy of a report on various irrigation projects in South Africa, which contains particulars of irrigation works now in course of construction, and also of proposed new works, the cost of which is to be defrayed by the Union Government or by Government loans granted to Irrigation Boards. The loan estimates for the year ending March 31, 1918, provide for the sum of 535,500*l.* being expended on these works; of this amount 362,500*l.* is to be spent on works now in hand, and 173,000*l.* is allocated to new schemes. The sum of 163,000*l.* is to be devoted to the following Government irrigation works now under construction: the Klipdrift irrigation scheme and the Hartebeestpoort scheme, both in the Transvaal Province; and the Olifants River (Van Rhynsdorp) scheme in the Cape Province; further instalments, to the amount of 199,500*l.*, of loans already granted to Irrigation Boards are to be made towards works now in progress. With reference to the new schemes proposed, 25,000*l.* is to be devoted to the Government irrigation scheme at the Orange River Islands, as a first instalment of an approximate cost of from 150,000*l.* to 200,000*l.* for the first section of the work. This scheme, however, is capable of being carried much further than the present estimate provides for. The complete project would cost approximately 750,000*l.* New loans to Irrigation Boards will absorb 148,000*l.* The following are the works projected under this heading:—

	Total cost. £
Kamanassie storage project (Outdshoorn)	360,000
Sundays River project (Uitenhage)	250,000
Middleton irrigation scheme (Somerset East)	40,000
Kaffir River irrigation scheme (Bloemfontein)	50,000
New loans to farmers and minor irrigation boards	120,000

During 1917–18 the sum of 85,000*l.* is to be allocated to the first four projects and 63,000*l.* to the last named. The Kamanassie scheme provides for the construction of water conservation works for the district of Oudtshoorn. This district has suffered severely from drought in late years, and also from heavy floods, which caused great damage to lands: the present irrigation works are inadequate. A site for the dam has been selected on the Kamanassie River. The length of the dam will be 1,265 ft., and on the right flank a waste weir will be constructed, 550 ft. in length, at 150 ft. above datum. It is probable that concrete will be the material chiefly used, and in view of the present very high cost of timber it is considered advisable to build the exposed surfaces in masonry or concrete blocks. The plans include the construction of a high-level canal, from the dam, for irrigation purposes. The Sundays River project is for the erection of a storage reservoir. The site which has been selected on the Sundays River will, owing to its width, necessitate the construction of a dam of more than 1,200 ft. crest length. The question of silting is an important one in this prospect, as the flood waters are heavily charged with silt and much heavy sand is also brought down. It is expected, however, that the use of sluices will minimise the trouble. The report in question, which contains maps and diagrams of the various irrigation projects, may be consulted at the Department of Commercial Intelligence.

CATALOGUES.

A.C. Electric Motors.—A catalogue giving very complete particulars and prices for one, two and three-phase motors, from ¼ brake horse-power to 120 brake horse-power, comes from the Langdon Davies Motor Company, 110, Cannon-street, London.

Electric Light Reducer.—An appliance for turning down or dimming a single electric light, named the "Dim-a-lite," is described in a catalogue received from Messrs. Pass and Seymour, Solvay Station, Syracuse, New York, U.S.A. It is a small rheostat which fits in between the lampholder and the lamp. It is made in four sizes, from 40 watts for 125 volts to 60 watts for 250 volts, and withstands a considerable overload.

Diffusing Reflector.—A reflector giving a diffused and indirect light, suitable for fine work which is trying to the eyes, is made by suspending an opalescent bowl under the lamp, reflecting into the ordinary inverted dished reflector. It is held from the rim by three clips and fine chains, and is shadowless and fully ventilated. It is made by the Sun Electrical Company, Limited, 18, Charing Cross-road, London, W.C. 2.

Electric Wiring System.—A complete series of fittings for wiring dwelling-houses and public buildings is described in a catalogue received from British Insulated and Helsby Cables, Limited, of Prescot, Lancashire. The line is made up of two D-section copper conductors, with prepared paper insulation, enclosed in a lead sheath, and is intended for surface fixing or being sunk in plaster. All the necessary boxes, ends, bases, roses, &c., are included in the catalogue. The system may be fitted up very quickly and cheaply and without soldering.

Swiss Engineering Works.—The Oerlikon Company, Norfolk-street, Strand, send a little booklet of illustrations of their works in Switzerland and of many electrical machines which they make. In an accompanying circular letter an assurance is given that their business is entirely managed by Swiss people, that over 98 per cent. of the labour employed is Swiss, and that the company's trade has successfully passed the scrutiny of the British Government and its Allies. The company is in a position to execute orders for electrical machinery for delivery in this country.

Vacuum Drying Machine.—Messrs. Manlove, Alliott and Co., Limited, Nottingham, send a catalogue describing the vacuum "Johnstone" dryer. It consists of a pan with steam jackets round the sides and part of the bottom, surmounted by a dome-shaped cover fitted with inlet hole, driving gear for the mixer and scraper which operates inside, vapour escape pipes, vacuum gauge, &c. Material, such as moist chemicals, is put in through the cover, constantly stirred during drying, and discharged through the bottom. The three standard sizes of the machine take charges of 5 cwt., 10 cwt. and 20 cwt. Continuous operation is possible, and caking of the material avoided. An open-topped type is also made. The drying can be regulated to any degree, and it can be effected at a low temperature if required.

Mercury Vapour Converter.—The Westinghouse-Cooper Hewitt Company, Limited, 80, York-road, King's Cross, London, send a description of this machine, the purpose of which is to transform alternating into direct current. A glass vessel containing mercury, and with the air exhausted to a high state of vacuum, is mounted at the back of a marble panel, on the front of which is fitted the rocking gear, switches, &c. Tilting the vessel makes a contact which vaporises the mercury and effects a flow of current transformed from alternating to direct. The instrument is sufficient for charging batteries for telephones, telegraphs, and car-engine ignition, or running small motors for medical work, &c. An efficiency of 85 per cent. is shown when operating at 220 volts output.

Air-Cooling Machinery.—The need for keeping machinery well lubricated, clean and cool has become more urgent with the development of high-speed engines and turbines coupled to generators. These developments all involve a decrease of dead weight of metal in comparison with the quantity of power generated or distributed. Many parts which cannot be oiled require to be kept cool and clean. To direct a current of cooling air on or through a machine creates, or increases, other difficulties, as dust and even grit are carried with the current. This problem as a whole has been taken up by Messrs. Davidson and Co., Sirocco Engineering Works, Belfast, and their solution of it explained in a catalogue entitled "Clean Air for Generator Cooling." Air is drawn into chambers where it is washed, dried and cooled, and then directed through the generator, motor or other machine to be cooled—the flow and temperature being regulated to produce uniform conditions. Particulars are given of 15 sizes of machine, supplying 4,000 cub. ft. to 60,000 cub. ft. per minute of clean cool air under pressure. The construction and working of the system are clearly explained and illustrated.

Milling Machines.—A catalogue from Messrs. J. Parkinson and Son, Shipley, Yorkshire, shows two types of machine for plain and universal milling, designed for heavy and rapid cutting. The column and baseplate are separate castings, the over-arm of solid steel bar, and the spindle of nickel steel. The feed motion is driven, not from the spindle, but either by a separate belt from the countershaft or by an independent electric motor. A centrifugal locking device renders the feed incapable of action until the spindle is running, and stops the feed when the spindle is stopped, whether in ordinary course or through a belt breaking. With this arrangement the maximum cut in cast-iron under good average conditions is equal to 10¼ cub. in., or 2¾ lb. of cuttings per minute: for instance, a cut 4 in. wide and ¼ in. deep at a feed of 10¼ in. per minute. The working surface of the table, in the universal type, is 46 in. by 10 in., with 50 deg. swivel to either side. There are 16 spindle speeds, ranging from 13 r.p.m. to 467 r.p.m., and 12 feed speeds, from ¼ in. to 10¼ in. per minute. The machine admits cutters up to 12½ in. diameter with the bracing arm in position. There is a full series of attachments, including dividing heads with plain division or index plates, or tailstocks to swing 10 in. diameter and take 27 in length, a choice of eight arbors, vertical and angular milling spindles, slotting and rack-cutting gear, vices and rotary tables.

Spiral-Wound Piping.—The Standard Spiral Pipe Works Company, of Chicago, U.S.A., send a catalogue giving illustrations and very complete measurements of a light steel pipe made of sheet metal. Strips of the metal are folded over to the flat at each side and wound spirally into a long tube with the folds outside. A narrow clamping-piece of similar fold overlaps the abutting edges and is tucked under the folds of the main piece, The result is a pipe with a smooth inside and a rib running spirally outside at a pitch of about 1½ diameters. The pipes are listed at 3 in. to 40 in. bore, the single walls being of $\frac{1}{16}$ in. to $\frac{1}{160}$ in. thick, and the ribs of four-fold thickness. Bursting pressures for every thickness and diameter are given in clear tabular form, with weights and prices per foot without flanges and in 20-ft. lengths flanged. A safe working pressure, cold, of course, is given as one-quarter of the bursting pressure. On this basis a pipe 3-in. bore and 16 U.S. gauge (= 0.064 in.) walls could be used for about 500 lb. pressure per square inch, and a 20-in. bore of the same metal about 90 lb. The largest size given is a 40-in. bore, with wall of 10 U.S. gauge (= 0.102 in.), with a bursting pressure of 410 lb., and therefore a working pressure of about 100 lb. Suitable flanges, elbows, tees, crosses, gates and other connections are shown in cast-iron. All the piping is asphalt-coated or galvanised after the making is completed.

Capstan Lathes.—A catalogue issued by Messrs. H. W. Ward and Co., Limited, Birmingham, almost merits the rank of an engineering handbook. Excellent illustrations are given of a series of these lathes, from 4-in. centre gripping ½-in. bar to 30-in. centre taking 2½-in. bar; and although these are now familiar, the detailed specification for each lathe will be useful for reference when a machine is wanted for definite kinds of work. The main value of the publication is in the part dealing with various "attachments" or "accessories" for use with the lathes. These include adapter bushes, release die and tap holders, various form tool holders, hollow mills, devices for boring, facing, knurling, internal recessing, chasing, reaming and tapering. All these are made to fit as substantial and integral parts of the machine. They are fully described and illustrated, and the method of attachment clearly shown. The general effect of so wide a choice of efficient fittings is to lift the machine out of the narrow category implied by the terms "capstan" and "turret." The reamer is an example of these devices—it is a very old tool which was always efficient for attaining an exact fit, either taper or parallel. It is essentially a fitter's hand tool, used to give a more exact touch to the best boring or drilling. When held firmly in a tool-box against a revolving work-piece its peculiar merits are destroyed. In the attachment shown in this catalogue the main body of the holder is firmly bolted to the turret, while the actual holding part is free to float radially, so that the reamer is allowed to follow its own axial line and make the hole its own size. The weight is taken on springs. If carefully used, in a bore very near the required diameter, the result will be in exact size and smoothness very near to skilful hand reaming. Messrs. Ward are willing to send a free copy of this book not only to possible buyers, but to any of our readers, foremen, tool setters or operators, who are interested in this kind of machine work. Applicants should write to the firm direct at Lionel-street, Birmingham, mentioning their place of employment. The book, of fully 250 pages, is well bound in limp cloth.

Uranium Steel.—According to *The Iron Age*, the production of ferro-uranium from the uranium oxide obtained as a by-product in the extraction of radium from its ores is to be investigated by the United States Bureau of Mines. Ferro-uranium enters into the making of uranium steel, used in Germany for the linings of big guns. Work will soon be begun on the production of sample lots of uranium steel and other special steels, for test by the Bureau of Ordnance of the War Department as to their suitability for use in guns. The work on gun steel will also require the use of electric furnaces. It has not yet been decided, adds our contemporary, whether this work will be done at Cornell or at one of the other universities which have offered facilities.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

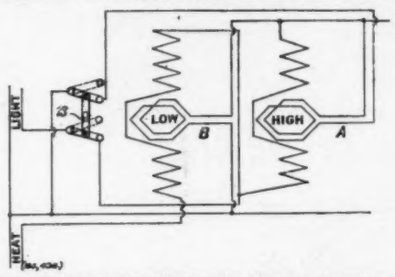
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any grounds mentioned in the Act.

ELECTRICAL APPARATUS.

104,498. L. Birks, and J. R. Templin, Fendalton, Christchurch, New Zealand. Metering Electricity. (2 *Figs.*) July 19, 1916.—This invention relates to the metering of electricity as a basis of payment by the consumer, and refers chiefly to cases where the supply is intended for domestic purposes. The object of the invention is to provide means whereby the customary forms of supply meters may be utilised to record all current supplied under special differential rates. In effecting this purpose the invention consists essentially in the employment of two meters A, B, so controlled by a hand-operated switch 13 that when the latter is in one position the heating circuits will be connected with the supply through the meter B on which the



low charge is made, while the lighting circuits will be disconnected. Upon the switch 13 being moved to its other position, however, the lighting circuits will be connected with the supply through the second meter A, on which the higher charge is made, while the heating circuits will also be connected, but through both meters, the result being that all current supplied for heating, while the switch is in the lighting position, will be simultaneously recorded by both and will therefore be charged for at the sum of the two rates. The two meters are not necessarily separate instruments, but may comprise an instrument in which two separate registering devices are included in a single case. (*Accepted June* 27, 1917.)

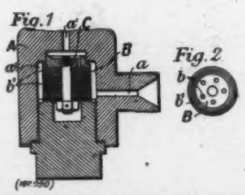
GUNS AND EXPLOSIVES.

107,045. J. A. Hill, Sheffield. Grenades. (4 *Figs.*) June 9, 1916.—This invention relates to grenades of the type comprising a weighted base and explosive charge on the forward part of the device and a charge of bullets adjacent to the base and adapted to be dispersed on the explosion of the explosive charge. The object of the present invention is to provide a device of the above type which may be thrown equally by hand or by mechanical means. The invention consists in a grenade

of the type referred to, comprising a weighted base, a compartment adjacent to the base charged with bullets *f*, and a forward compartment charged with explosive *e*, so arranged that when the device reaches the highest point in its trajectory and begins to descend the weighted base will assume the lower position, so that on explosion the bullets will be discharged downwards through the base in the direction of travel of the device, and will thus give a maximum of destructive effect. (*Accepted June* 27, 1917.)

GAS ENGINES, PRODUCERS, HOLDERS, &c.

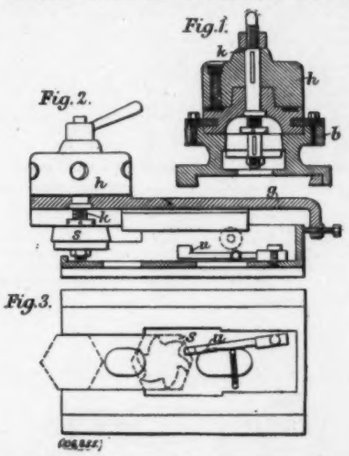
107,090. Vickers, Limited, Westminster, and J. McKechnie, and J. P. Clear, Barrow-in-Furness. Internal-Combustion Engines. (4 *Figs.*) July 8, 1916.—This invention



relates to straining or filtering apparatus intended for the straining of heavy oils used as fuel in internal-combustion engines. The device is of the type employing a number of plates or discs B secured together to form a pile with narrow channels formed between the plates leading from the periphery to a communicating channel or channels traversing the pile. According to this invention, very narrow channels are formed in an annular rib or raised ring b^1, on one of the faces of the said plates B, and the plates are secured together so that the raised surface of a plate meets the adjacent surface of the next plate. The channels may be formed by knurling or milling the face of the raised ring, or radial grooves of triangular form may be cut in the raised portion of the plate. In the construction of strainer preferred the pile of plates is held in an outer casing A having an inlet opening *a* to a small chamber a^2 surrounding the pile, the plates being formed with a series of perforations *b* leading to a discharge opening in a thick perforated disc C secured in the casing at the outlet a^1, to which disc the plates are firmly clamped by a screwed stud. The end plate is left unperforated, so as to close the pile at this end and allow the liquid to flow inwardly under pressure through the fine straining channels into the communicating channels formed by the perforations, and thence to the outlet at the other end of the pile. No particle having a greater diameter than the width of the channels or grooves can pass the strainer. (*Accepted June* 27, 1917.)

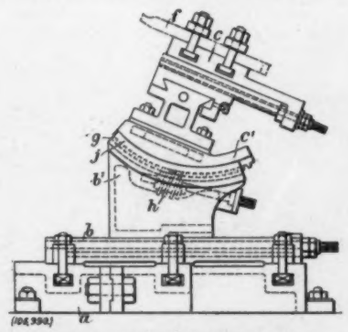
MACHINE AND OTHER TOOLS, SHAFTING, &c.

106,855. C. H. Adams, and S. H. Adams, Fulford, York. Turret Capstan Lathes. (5 *Figs.*) June 5, 1916.—The object is to simplify the construction of revolving turret lathes. In the first place the turret head *h*, which carries the tools, is keyed upon and revolves with a central pin *k* which passes through a boss or bearing upon the turret table *g* which slides upon the fixed saddle. The pin projects beneath the turret table and carries a parallel-sided locking wheel *s*, which is keyed thereon. The number of sides of this wheel corresponds with the number of tools. The wheel *s* slides between the two interior parallel sides of the saddle *b*, and the width between is such that when the turret head *h* is brought forward the sides of the wheel *s* are in close contact therewith and the wheel cannot revolve, and when it is drawn back into the rear position the wheel *s* comes



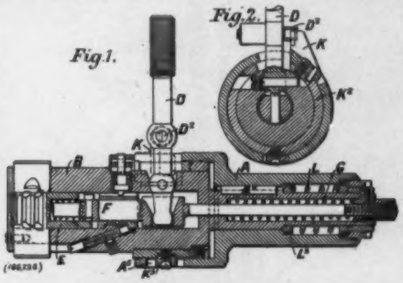
into a wider space, and is revolved by means of a ratchet and striking lever *u* with which it comes into contact. This striking lever is placed within the saddle, in the same line as the wheel *s*, to which a star or ratchet wheel is attached. In operation, the table *g* is drawn back, the ratchet wheel coming into contact with the striking bar *u*, which pushes round the wheel *s* until another side becomes parallel to the saddle frame *b*, then the table with its turret is sent forward, the latter being held rigid during the forward travel. When the end of the cut is reached, the table with its attached turret is drawn back, the turret revolves and the operation is repeated, the object of the above being to bring the various tools carried upon the turret head into position, and to carry the tool which is in position rigidly up to its work. (*Accepted June* 20, 1917.)

106,990. S. J. Jones, London. Slide Rests. (3 *Figs.*) April 25, 1917.—This invention relates to slide rests for lathes of the type in which the tool-carrying portion of the rest is made angularly adjustable to the horizontal and about a horizontal centre or axis, so that the tool can be inclined at any desired degree of inclination. The bed of the lathe is indicated at *a*, the base or lower part of the slide rest being shown at *b* and the upper part or tool-carrying portion being shown at *c*. The part *c* is subject to movement whereby the angle of inclination



of the tool *f* can be altered about a horizontal axis or centre. For this purpose the standard or support b^1 forming part of the lower portion *b* is curved or shaped at the top to a segment as shown at *g*. This curved part or track is adapted to engage a correspondingly curved base c^1 to the upper part *c*, so that by means of the parts *g* and c^1 the arrangement or angle of the part *c* can be altered relatively to the support b^1. For this purpose a worm, as *h*, is mounted on a shaft journalled within the support b^1, this worm engaging a segmental rack *j* on the underside of the part c^1. (*Accepted June* 20, 1917.)

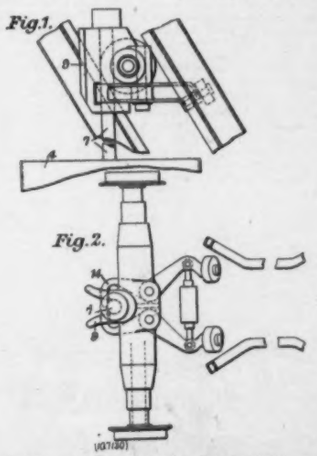
106,728. A. Herbert, Burford, Oxon, and A. H. Lloyd, Earlsdon, Coventry. Screw-cutting Taps. (4 *Figs.*) August 16, 1916.—This invention relates to screw-cutting taps of the type having a stock which contains a sliding plunger for the operation of the chasers. This plunger is acted upon by a spring which withdraws the plunger and so causes the tap to be collapsed, and the plunger is moved forward, and the tap expanded, by means of a lever. According to this invention, the stock can slide in the tap-holder during the tapping operation, and this sliding movement is adapted to trip a catch which holds the lever in its set position. Thus between the stock and the holder there may be a sleeve having a pin engaging an angular slot in the holder or *vice versa*. This sleeve is caused to twist as the stock advances, and it may carry a bracket engaging the lever and holding the latter in its set position. The holder A is tubular, as also is the stock B, and the latter, due to the tapping operation, slides in relation to the former (to the left in Fig. 1), when the holder is arrested by some suitable stop, there being



employed a key or keys A^2 to prevent relative rotation. The stock has pivoted to it the lever D engaging the plunger E, F, which passes through the stock and is acted upon by a spring G. The lever D carries a spring catch or pawl D^2, which is adapted to hook behind a bracket K when the lever is in its set position and the tap expanded, as is shown. The bracket K is formed on a sleeve K^2 interposed between the stock and the holder, and a pin K^3 on the sleeve lies in an angular or inclined slot A^3 in the holder A. As the stock moves to the left, the holder being arrested by a suitable stop, which is not shown, this pin and slot connection K^3, A^3, causes the sleeve to twist and the bracket K to slip out of engagement with the catch D^2. The lever then shoots forwards under the influence of the spring G, and the tap is collapsed, the stock returning to its normal position. It is frequently desirable that there should be a resilient connection between the holder A and the stock, and this may be effected by interposing a spring L between a collar L^2 on the stock and a fixed abutment formed on the holder. This spring maintains the stock in its proper position, but allows it to yield slightly. (*Accepted June* 13, 1917.)

MINING, METALLURGY AND METAL WORKING.

107,130. A. Sahlin, London. Blast-furnace Hoists. (3 *Figs.*) September 22, 1916.—This invention relates to blast-furnace hoists of the class in which charging buckets carried by trolleys are brought to the foot of a usually-inclined framework or track and there engaged respectively with a trolley frame or frames, which are guided by the framework and hoisted to the furnace top by means such as a rope or chain, the engagement being usually effected by causing the head of a bail, link, rod or like part attached to the bucket to be caught by a hook or Y-shaped piece, or like part, of the hoisting trolley. According



to the present invention a safety device is provided for preventing the bucket escaping from the hook or the like part carrying it, and preferably, also, from swinging during its travel on the framework at desired points thereon. This may be effected by providing the hook, Y-shaped piece, or the like 9 of the hoisting trolley with a bar, hook, tongs, nippers, or the like 14, which is, or are, adapted to be placed in front of the bail, link, rod, or the like 7 of the bucket 4, in such a position that it cannot escape from the hook, Y-shaped piece, or the like 9, of the hoisting trolley, until automatically released at the desired point. (*Accepted June* 27, 1917.)

MOTOR ROAD VEHICLES.

107,149. Albion Motor Car Company, Limited, and T. B. Murray, Scotstoun. Back Axles. (2 *Figs.*) October 28, 1916.—The invention relates to "live" back axles intended for use in heavy commercial vehicles and of the type in which there is a final train of reduction gearing. In carrying out the invention the body of the axle is of well-known ring type, the axle proper consisting of a single forging having two tubes extending laterally from a central annular portion. According to the first part of the invention there is forced into each of the inner and enlarged openings of the tubes A within the annulus

a sleeve B. Or these sleeves may be made in a piece with the tubes. Rigidly mounted on these sleeves are the inner races of two ball or roller bearings C, the outer races of which carry the pinions of the final drive E. These pinions are belled to receive the bearings and the inner ends of the sleeves, and have bosses projecting within the sleeves for their attachment to the driving shafts lying within the tubes. The axle is arranged with the plane of its annulus horizontal, and a semispheroidal enclosing case H, provided with the usual lubrication arrangements, is bolted beneath it. To the upper face of the annulus is bolted an annular case J. Closing the upper end of this is a second spheroidal case K provided with housings for the rear end of the propeller shaft M and with axial bearings for the intermediate and differential shaft P which lies parallel with and above the axle proper, all in known manner. The differential gear carried

Fig. 1.

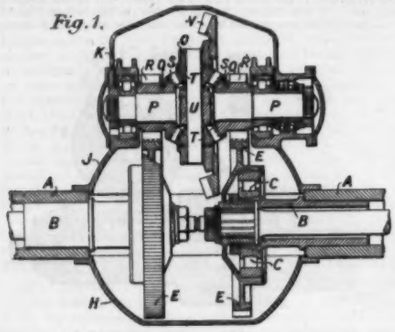
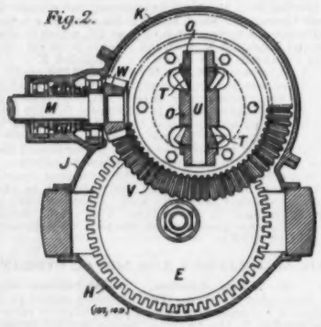
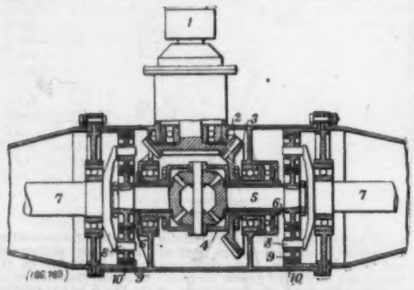


Fig. 2.



on this shaft, with the pinions gearing with the final pinions on the internal axle shafts, consists of a single-piece central member O having laterally-extending stub axles or trunnions P forming the differential shaft. On the axles P are loosely-mounted sleeves Q on which are formed pinions R of the final reduction train and which gear with the final drive pinions E. On the sleeves Q are also formed the central pinions S of the differential gear, the planetary pinions T of which are mounted in apertures in the member O and carried on a long pin U passing therethrough. The bevel wheel V by which the drive is transmitted from the bevel pinion W on the end of the propeller shaft M is bolted directly to the member O. The propeller shaft is provided with journal and thrust bearings, as are also the stub shafts P. (*Accepted June* 27, 1917.)

106,783. F. H. Royce, and Rolls-Royce, Limited, Derby. Motor Road Vehicles. (1 *Fig.*) December 8, 1916.—This invention relates to back axles for motor road vehicles of the type in which two epicyclic reduction gears are used in addition to the usual differential gear and right-angle driving gear from the cardan or propeller shaft to the back axle. The propeller shaft 1 conveys the drive from the prime mover to the bevel wheel 2. This meshes with a bevel wheel 3, which in turn is rigidly secured to the planet carrier of the differential gear 4,



The two co-axial shafts 5 are provided with pinions or sun wheels 6. Mounted on the two wheel-drive shafts 7 are planet carriers 8, which each accommodate two planet wheels 9. Two internally toothed rings 10 are bolted to the casing 11, and are so located that the planet wheels 9 are driven round in mesh with the internal teeth by the sun wheels 6. Thus the wheel-drive shafts 7 rotate at a speed which is lower than that of the shafts 5, in accordance with the relative dimensions of the members of the epicyclic trains. (*Accepted June* 13, 1917.)

106,925. J. Ridley, Dennistoun, Glasgow. Change-Speed Mechanism. (5 *Figs.*) October 2, 1916.—This invention relates to change-speed mechanism for motor road vehicles of the type in which forward drive at the selected one of two or more speeds and reverse drive are transmitted by means of skew bevel gearing to the rear axle. 1 denotes a torque tube which surrounds the cardan shaft 2 and takes both the torque and driving push of the rear axle. The torque tube 1 fits into a yoke 3 at the forward end. Across the arms of the yoke 3, and on top, is fixed a gate change-speed plate 4, through which passes the change-speed lever 5. The lever 5 is pivoted to a sleeve 6 under the yoke 3, the yoke 3 having a bearing in which the sleeve 6 can oscillate without allowing any backward or forward movement, the pivot of the lever 5 being below the centre of the sleeve bearing. The lever 5 engages stops on the solid spindle 9 extending beneath the torque tube 1 and disposed coaxially of the sleeve 6 and connected to the double fork of the forward change-speed gears. Co-axial with and enveloping the spindle 9 is the reverse-actuating tube 11, which passes through and has a bearing in the sleeve 6. Fitted to the sleeve 6 is a cam 12

Fig. 1.

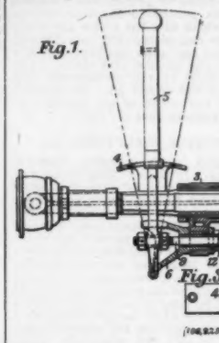


Fig. 2.

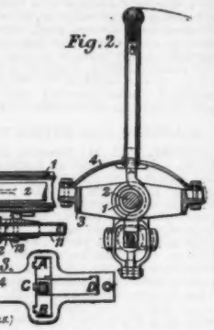
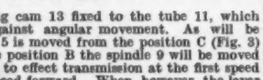


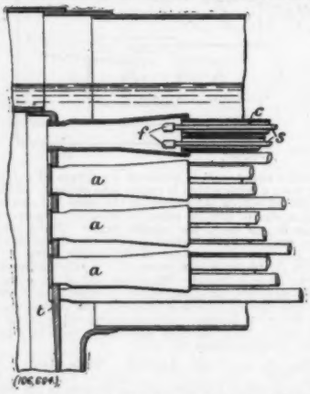
Fig. 3.



engaging a corresponding cam 13 fixed to the tube 11, which latter is restrained against angular movement. As will be evident, when the lever 5 is moved from the position C (Fig. 3) to the position A or the position B the spindle 9 will be moved endwise in the direction to effect transmission at the first speed forward or the second speed forward. When, however, the lever is moved from the position C to the position D, the sleeve 6 is moved angularly, and, as the inclined face of the cam 12 rides over the inclined face of the cam 13, the tube 11 is moved endwise and thereby shifts the reverse pinion into engagement with its co-operating bevel wheel. (*Accepted June* 20, 1916.)

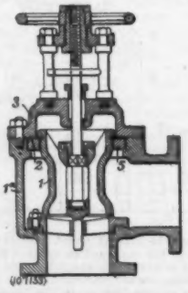
STEAM-ENGINES, BOILERS, EVAPORATORS, &c.

102,604. C. E. Adams, London. Tubular Steam Boilers. (14 *Figs.*) December 6, 1915.—The invention relates to boilers in which groups of tubes are connected with a tube plate by means of collectors, and consists, essentially, in the provision of tubular connections or collectors *a* having tapered, conical or similar formation, so that the interior is of larger diameter at one end than the other. The smaller ends of those collectors, which are situated at the fire-box end, have a cross-sectional area of



opening to the fire-box which is equal to or greater than the total cross-sectional area of the openings of respective groups of fire tubes *c* connected to the larger ends of such collectors. In the case of a boiler provided with superheater tubes *s* the flow and return superheater tubes project into the collector *a* adjoining the fire-box tube plate *t*, and the ends of such superheater tubes are advantageously connected by junction pieces or bends *f* situated within the collector. (*Accepted June* 20, 1917.)

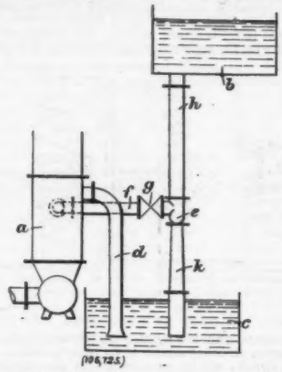
107,153. D. Cockburn, and D. MacNicoll, Cardonald, near Glasgow. Steam Valves. (2 *Figs.*) November 8, 1916.—This invention relates to steam valves of the type fitted with a flexible ring or disc serving to ensure balance and steam-tightness of the valve, and consists in an improved arrangement



such that the flexible ring is closely imprisoned all round, so that, in the event of fracture of the ring, no fragments of appreciable dimensions can be carried into the steam passage-way, the only possible outlet for any fragments being by way of slight clearance intervals, which in practice are narrower than the thickness o

the ring. 1 denotes the valve body, fitted in a casing 1a; 2 denotes the flexible ring, which occupies a position in the region of the junction of the valve casing 1a and its cover 3, and which is imprisoned on one side by the cover 3 and a face on the valve, and on the other side by the upper edge of the valve casing 1a and a guard-ring 5 fitted to, or forming part of, the casing 1a, sufficient freedom being allowed for deflection of the ring 2 to the extent necessary to compensate for expansion. The inner edge of the flexible ring 2 is in register with the inner edge of the face on the upper end of the valve body 1, the upper end of the valve body 1 being spaced by only a slight clearance interval from the interior face of the cover 3, and the part of the valve body 1 immediately below the face being spaced by only a slight clearance interval from the inner face of the guard-ring 5. The flexible ring 2 is thus entirely imprisoned, and, while steam may leak past the inner edge of the flexible ring when the valve is opened, there is no passage through which any fragment of the flexible ring of material dimensions can find its way in event of breakage of the flexible ring. (*Accepted June* 27, 1917.)

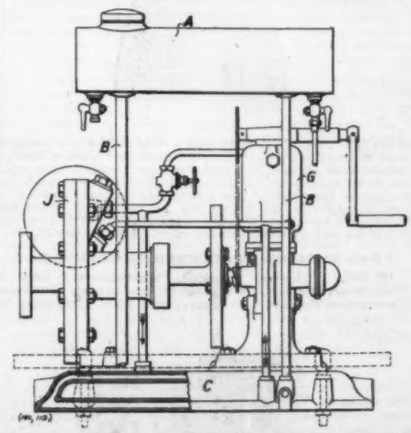
106,725. Willans and Robinson, Limited, and R. J. Kaula, Rugby. Jet Condensers. (4 *Figs.*) August 9, 1916.—This invention relates to the supply of condensing water to, and the withdrawal of air from, steam condensers of the jet or injection type, and consists in arranging for the condenser to draw its water of condensation from a suction tank situated as far as practicable or necessary below the level of the source of supply of the condensing water, and utilising the difference in level between the source of supply and the suction tank to provide a head of water which is employed to discharge the air from the condenser. *a* represents the condensers, *b* the source of supply of the condensing water, *c* the suction tank, and *d* the suction pipe through which the condensing water passes



from the suction tank to the condenser. In the arrangement illustrated the means employed to discharge the air from the condenser consists of a water-jet ejector *e* connected to the condenser by the pipe *f*—provided with a valve *g*. The actuating or motive-power water for the ejector is obtained from the source *b* by way of the pipe *h*; and the water is discharged through the pipe *k* into the suction tank *c*. The ejector is placed as far below the source of supply *b* as is practicable or is necessary to obtain the desired effect. The condenser draws its condensing water from the tank *c* by way of the suction pipe *d*. Suitable means are provided for separating the air discharged by the ejector from the condensing water before the latter is admitted to the suction pipe *d*. The difference in level between the source of supply *b* and the suction tank *c* is sufficient to provide the head required by the air ejector. (*Accepted June* 13, 1917.)

PUMPS.

107,113. The Villiers Engineering Company, Limited, and G. Funck, Blakenhall, Wolverhampton. Portable Pumping Apparatus. (2 *Figs.*) August 25, 1916.—The invention comprises the combination with an internal-combustion engine G, and a centrifugal pump J adapted to be directly coupled thereto, of a fuel tank A, located over the engine and pump so as to form a protection for them and connected to the bedplate C of the apparatus. The bedplate can be hollow and operate as a



silencer, and it can be double-walled for cooling by circulating water. Feet or prongs can be provided on the bedplate to grip the ground. The water-cooling system for the engine can be provided with a water cock having a by-pass constantly open. The fuel tank can carry the control mechanism and devices such as the lubricators, and it can be supported by pillars B from the bedplate, suitable handles being provided either to the tank, pillars or bedplate. The accessories which in the ordinary way are not fitted directly to the engine are all carried by the fuel tank and the baseplate, so that a compact and light construction is produced. (*Accepted June* 27, 1917.)